sustainability

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Going beyond Global Indicators—Policy Relevant Indicators for SDG 6 Targets in the Context of Austria

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Abstract: Bringing forward sustainable transformation as envisioned within the Agenda 2030 requires comprehensive monitoring of the 17 Sustainable Development Goals (SDGs) formulated therein. To monitor and report progress on goal 6 on clean water and sanitation and its eight pertinent targets, 11 indicators were stipulated in an elaborated process. Yet, through continuous scientific and public scrutiny and debate several gaps and weaknesses were identified. Amongst others, these globally defined indicators are found to reflect weakly the diversity of national realities, capacities and levels of development. To translate the targets into national contexts and fully cover all aspects of the SDG 6 targets, the utilization of complementary indicators is recommended. Within this paper, following a critical appraisal of the SDG 6 indicators, possible complementary indicators are collected from literature and screened based on their quality, relevance for the national context and data availability. A deepened status quo of the SDG 6 targets and corresponding problem areas are outlined for the context of Austria, where water and sanitation infrastructure as well as regulation and governance of water bodies are widely established. Despite increasing the monitoring effort, it is concluded that complementary indicators are practicable to support coherent policy-making and ultimately contribute to the Agenda 2030's aspiration that all countries take action.

Keywords: sustainable development goals; Agenda 2030; safe water and sanitation; monitoring; water management; national context

Citation: Germann, V.; Langergraber, G. Going beyond Global Indicators—Policy Relevant Indicators for SDG 6 Targets in the Context of Austria. *Sustainability* **2022**, *14*, 1647. https://doi.org/10.3390/su14031647

Academic Editors: Nuno Crespo and Nádia Simões

Received: 31 December 2021
Accepted: 25 January 2022
Published: 31 January 2022

1. Introduction

With the Agenda 2030, 193 countries worldwide agreed upon 17 ambitious and globally applicable Sustainable Development Goals (SDGs), of which goal 6 aims to "*ensure availability and sustainable management of water and sanitation for all*" [1] (p. 18). Prior to the SDGs, the importance of water and sanitation was highlighted by declaring it a human right in 2010 [2]. The significance given to water-related issues was reconfirmed by introducing access to water and sanitation, unlike in the preceding Millennium Development Goals (MDGs), as a "*self-standing*" [3] (p. 796) goal within the Agenda 2030. Therein also an important shift in the conceptualization of development towards a "*universal aspiration for human progress that is inclusive and sustainable*" [4] (p. 6) took place. In contrast to the MDGs, which focused on countries in the Global South, this illustrates the aspired global applicability of the Agenda 2030 [5]. UN Water [6] further underpins that SDG 6 "*goes far beyond water and sanitation services to cover the entire water cycle*" [6] (p. 4) and that it is critical to sustainable development. Progress towards SDG 6 is found to have "*catalytic effects across the entire 2030 Agenda*" [6] (p. 4), which is supported by numerous publications emphasizing the many interlinkages of SDG 6 with other SDGs [7–12]. Nonetheless, action needs to be accelerated as the world is off track to reaching SDG 6 [6].

As "*we only manage what we measure*" [6] (p. 4) and considering that the selection of indicators is highly political [3,4], the need for a robust indicator framework that encourages a broad, iterative debate is evident [13]. SDG 6 is specified using eight targets, two of which are so-called means of implementation (MoI) targets. To measure progress towards these targets, assist decision-making and ensure that no one is left behind (LNOB), 11 indicators were formulated [14], which should be regularly monitored and reported. Yet, data gaps are persistent [6] and several deficits within the SDG 6 indicator framework have been identified [15–17]. Among others, these include the lack of comparable metrics at subnational level and benchmarking progresses that acknowledge the different stages of development of countries worldwide [18]. Further, consistent linkage of MoI and outcomes [17] and coverage of specific aspects like energy and nutrient recovery [15] as well as finance [16] are found to be missing. Critically reflecting the indicators and addressing identified gaps and weaknesses is recognized to be crucial to capture the real status of sustainable development and find effective solutions [16]. Concerns have been raised continuously that globally defined indicators might be problematic in terms of data availability and insufficient to reflect the diversity of national and subnational realities, capacities and levels of development [17,19,20].

As a practicable way to address some of these gaps and translate the targets into national and subnational contexts complementary indicators at country level have been suggested [15,16,19]. UN agencies expect that the global indicators will build the core of possible alternative indicator sets to monitor the SDGs, but acknowledge that complementary and different indicators for monitoring at regional, national and subnational level will be developed by the member states [1,21,22]. Within the Monitoring Guide for SDG 6, a number of complementary indicators is outlined [14]. The global indicators are considered as a subset of indicators and countries are encouraged to share additional information and set their own goals, indicators and benchmarks aligned with the SDGs and according to national circumstances [23,24]. Generally, data shall be disaggregated to cover particular groups of the population [1,21]. While arguably the introduction of new indicators can increase the monitoring burden for countries and use up valuable means that might be needed elsewhere, awareness of potential gaps and the utilization of relevant and effective indicators is even more important [15,16].

Consequently, a lot of research has already been done to critically analyse as well as amend and adapt the existing set of indicators. Essex et al. [15] present a set of complementary indicators that can be very helpful for country-to-country comparison but neither elaborate on in-depth critiques at target or indicator level nor draw implications at country-level. While underlining the need for complementary indicators that are SMART (Specific, Measurable, Achievable, Relevant and Time-bound) as well as for detailed analysis of SDG 6 to impede regrettable investments, they emphasize that the final selection of indicators and quantitative targets is ultimately a political decision. Bhaduri et al. [20] analyse the SDGs from a water perspective and identify several research gaps and challenges concerning implementation and monitoring. They conclude that indicators need to be simple and SMART but at the same time allow for policy makers to capture progress and complexity of sustainability, two requirements they judge the official set of indicators not to fulfil adequately. Similarly, Guppy et al. [16] assess critical gaps in the SDG 6 indicator framework and describe three mechanisms to assist national governments to close these gaps. Besides international support and an integrated approach, they propose the utilization of complementary indicators as one of the options but do not go into detail on potential indicators. Several other papers analyse one or two targets, directing, e.g., on WASH (Water, Sanitation and Hygiene) targets [18,25–27], Target 6.4 [28], 6.5 [29–31], 6.6 [32], MoI targets [17] or other aspects such as interlinkages [8,13], gender [33] or citizen science [34].

To the authors' knowledge no research has been published so far, that comprehensively assesses all SDG 6 targets and corresponding gaps and weaknesses of the indicators in-depth through the lens of a country in the Global North with widely established water and sanitation infrastructure as well as regulation and governance of water bodies largely in place. This research consequently aims to contribute to the Agenda 2030's aspiration to acknowledge that "*all countries take action*" [1] (para. 28) and shed further light on aspects that are not fully covered by the core indicators. Ultimately, national and international stakeholders shall be supported with the identification of local problem areas, coherent and informed decision-making and effective implementation of SDG 6. In this paper, the 11 indicators of the SDG 6 targets are critically discussed from the perspective of a country in the Global North and complementary indicators for the SDG 6 targets reflecting national contexts are identified from literature. These indicators are then evaluated on whether they fulfil the SMART criteria and according to their relevance for the national context. The main part of the paper is structured along the SDG 6 targets and comprises a critical appraisal, potential complementary indicators and, derived from these, a broadened status quo of each target in a national context. Finally, we summarize general findings from the discussions on the indicators.

The work was carried out within the frame of the project UniNEtZ (Universitäten und nachhaltige Entwicklungsziele—translation: Universities and Sustainable Development Goals) [35,36] in which 17 Austrian universities and research institutions jointly developed options for achieving the SDGs in Austria. Thus, the approach is illustrated by the example of Austria, based on which the identified indicators and the status quo of the achievement of SDG 6 targets are discussed. In Austria, water and sanitation infrastructure is generally established and overall water availability is high. Water governance and policies are widely in place and, as Austria is a member of the European Union, many of these are based on EU legislation. Doubtlessly, a broad diversity of national contexts in the realm of SDG 6 exists also within the Global North. Yet, considering these potentially favourable conditions, Austria is found to be a representative example for a country in Central Europe to assess and illustrate where there might still be need for action to fully achieve all aspects of the SDG 6 targets.

2. Materials and Methods

The methodological approach used in this paper is depicted in Figure 1 and comprises:

1. the collection of possible indicators for the achievement of SDG 6 from literature;
2. the assessment of these indicators on whether they fulfil the SMART criteria; and
3. on their relevance for the Austrian context;
4. a check of data availability for these indicators for Austria; and
5. the illustration of additional information that can be drawn from these indicators and the corresponding data.

Steps (1) and (2) result in a collection of SMART indicators as a basis for further assessment. Steps (3) to (5) filter this collection for the indicators most relevant and applicable in the national context and allow to draw corresponding implications for the case of Austria.

In the following, the methodological steps are described in more detail:

Step (1) A literature search in Scopus and Web of Science was conducted on 23 November 2021 to allow a critical appraisal of the SDG 6 targets as well as indicators and collect potential complementary indicators suggested for the assessment of the achievement of the SDG 6 targets. The search strings used and the corresponding number of results are outlined in Table 1:

Table 1. Search strings used for the literature search in Scopus and Web of Science on 23 November 2021 and results of the follow-up screening.

Data Base	Search Strings/Screening Method	# of Results
Scopus	TITLE-ABS-KEY (“indicator*” AND “SDG*” OR “Sustainable Development Goal*” OR “Agenda 2030” OR “2030 Agenda” AND “SDG 6” OR “goal 6” OR “water and sanitation” OR “target 6*” OR “indicator 6*”)	160
	TITLE-ABS-KEY (“indicator*” AND “SDG*” OR “Sustainable Development Goal*” OR “Agenda 2030” OR “2030 Agenda” AND “SDG 6” OR “goal 6” OR “target 6*” OR “indicator 6*” OR water OR sanitation) AND TITLE (water OR sanitation)	+109
Web of Science	“indicator*” AND (“SDG*” OR “Sustainable Development Goal*” OR “Agenda 2030” OR “2030 Agenda”) AND (“SDG 6” OR “goal 6” OR “target 6*” OR “indicator 6*” OR “water and sanitation”) in “topic”	+16
	“indicator*” AND (“SDG*” OR “Sustainable Development Goal*” OR “Agenda 2030” OR “2030 Agenda”) AND (“SDG 6” OR “goal 6” OR “target 6*” OR “indicator 6*” OR water OR sanitation) in “topic” AND TITLE (water OR sanitation)	+18

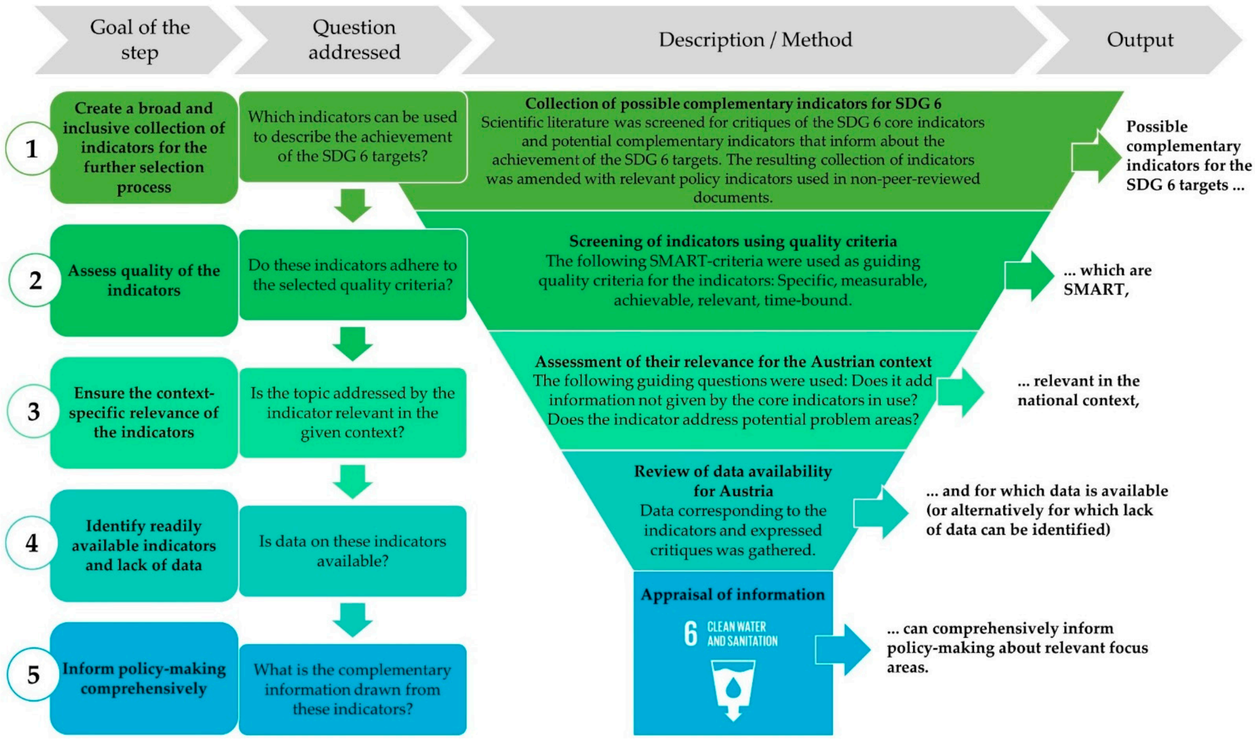

Figure 1. Illustration of the methodological approach for the assessment of indicators for the targets of SDG 6 used in this paper (own illustration).

In total, the search strings yielded 303 results. These were first screened based on title and abstract, followed by a refined screening of the resulting selection using the entire document. The documents were screened for possible complementary indicators for SDG 6, which were then added to the collection of indicators and aligned with critiques concerning the SDG 6 indicators therein. The following sources were used to amend the set of indicators from peer-reviewed journals with widely used policy indicators in the national, European and international context:

- Indicators from OECD [37];
- Indicators from EUROSTAT [38];
- Complementary indicators from the Joint Monitoring Programme (JMP), on WASH in schools and health facilities [39] as well as menstrual hygiene [40], and other UN agencies [14,41,42].

As the SDG "*indicators should be disaggregated, where relevant, by income, sex, age, race, ethnicity, migratory status, disability and geographic location, or other characteristics*" [43] (p. 15), disaggregation of the indicators was included in the review wherever this was the case. The paper explicitly addresses the national context, where the core indicators are often not sufficient to make informed policy decisions. The aim of step (1) is to ensure a broad and inclusive basis for the further selection process.

As this study focuses on the context of Austria, indicators that explicitly referred to low- and middle-income countries and could be assumed not to be relevant in the Austrian context (e.g., time to collect water, indicators on water-related diseases and on the type of user interface/toilet) were not included in the assessment.

To help orientation, categorization of the indicators was undertaken, albeit accepting that overlaps exist (e.g., between disaggregation and availability/equity). Categories for the WASH targets (Target 6.1 and 6.2) were formulated along the normative criteria of the right to water and sanitation (availability, quality, acceptability, accessibility and affordability) [44] and amended with the aspects of infrastructure, disaggregation and in the case of Target 6.2 hygiene. Other critiques were categorized as appearing in the references.

Step (2) To assess the quality of the indicators the SMART criteria, an acronym for "specific, measurable, achievable, relevant and time-bound" [15] (p. 1), were used as guideline. There are several definitions for the SMART criteria [15,20,45,46]. In Table 2 the SMART criteria as used in this paper are defined. All indicators listed as potential complementary indicators for the targets adhere to these criteria.

Table 2. Description of the SMART criteria as used in this publication adapted from [15,20,45,46].

Criteria	Definition
Specific	The indicator is precisely formulated.
Measurable	It is feasible to collect data for the indicator; the indicator is clearly defined and measurable.
Achievable	A target value can be specified, but does not have to be defined yet as for some indicators this might require normative considerations and extensive stakeholder discussions.
Relevant	The indicator can be linked to one of the SDG 6 targets or specifically addresses one of the critical aspects raised.
Time-bound	The indicator can be monitored at a desired frequency and allows to track changes.

Step (3) In this step, the relevance of the topic addressed by the indicator in the context of Austria was assessed (whereas the relevance in step (2) addresses the SDG 6 targets in general). To assess the relevance for the national context in Austria the following questions were addressed and if confirmed the indicator was added to the set of indicators:

- Does the indicator add information not given by the core indicators for SDG 6?
- Does the indicator address a potential problem area in the national context of Austria?

Step (4) In the next step data availability for information on these indicators for Austria was checked. Some data that were available for Austria do not explicitly correspond to the indicators recommended by the literature or were so far only assessed within a short-term case study. This data was still added to the list in case it could be directly linked to one of the critiques expressed and complemented the given information. For several indicators data (in more detail) might exist, but they were not publicly available. Although both development over a longer period of time and spatial and seasonal scaling of many indicators could be relevant for policy making, we focused on one value per indicator in this paper. The goal was to illustrate possible indicators and data sources, to give an initial starting point, and to remain concise. Further, some authors introduced composite indexes, that might be useful in certain cases (e.g., to capture interlinkages) but they were not focus of this publication and therefore largely omitted, except when readily available data was available and complemented the given information.

Step (5) In a final step based on the critical aspects addressed as well as the complementary indicators a broadened understanding of the challenges related to the SDG 6 targets in Austria beyond the core indicators was described and if necessary amended by relevant case-specific literature.

3. Results and Discussions

3.1. Overview on SDG 6 Targets and Indicators

Table 3 presents an overview of the 8 targets and 11 core indicators for SDG 6 as defined by the UN, Target 6.a and 6.b are so-called Means of Implementation (MoI) targets.

3.2. Indicators for Target 6.1

3.2.1. Critical Appraisal of Indicators for Target 6.1

Many shortcomings of the corresponding MDG 7C, that aimed to halve the proportion of people without sustainable access to safe water and basic sanitation, are addressed within the methodology of the Indicator 6.1.1 [3] and make it a "*powerful and politically relevant indicator*" [20] (p. 4). Still, the core Indicator 6.1.1 is criticized for inadequately covering some of the aspects formulated in the target. The integral aspect of affordability is not clearly reflected in the indicators methodology [16,20]. Potential monitoring approaches are scrutinized from various angles in the JMP Report on measuring WASH affordability [47] for both Target 6.1 and Target 6.2. As specified in the report, despite being also mentioned in several other SDG targets, monitoring of affordability is generally scarce within the SDG indicator framework. At national level, the use of readily available studies and data (e.g., income and expenditure surveys) is recommended and in turn can feed back into global monitoring [47]. Further, Guppy et al. [16] underline that the monitored availability at household level does not fully cover accessibility and equity, which can be affected by a range of social, health, environmental and political factors. As Guppy et al. [16] underscore, the call for *universal access for all* also implies schools, healthcare facilities, places of work and public spaces. The Special Rapporteur on the human rights to safe drinking water and sanitation clarifies that "*Goal 6 clearly looks beyond merely addressing access to water and sanitation at the household level. Rather, it requires States to implement actions to improve access for everyone, wherever needed*" [48] (p. 4). While monitoring of Target 6.1. in schools and health facilities is being established [39], other public spaces are still not reflected by the indicators. To capture the aspect of equity, disaggregation by age, gender, income and geographical location appears to be crucial [16,18,33,49]. However, it might be insufficient to adequately cover vulnerable and marginalized groups, making in-depth assessment necessary to uncover aspects like disability [18,25] and homelessness [27]. Vulnerable and marginalized groups can include persons with special physical needs (e.g., sick and elderly people), users of health facilities, educational facilities and retirement homes, prisoners, refugees, homeless people, travellers and nomadic communities as well as people without water and sanitation in their housing or workplaces [27]. As Bhaduri et al. [20] emphasize, any value below 100% effectively corresponds to a violation of the human right to water [2]. Another aspects that needs to be considered from a human rights perspective is acceptability (e.g., concerning colour, odour, taste and cultural prescriptions) [26]. Other critics emphasize that the link to water quality [3,8] and the broad range of possible contaminants [16] are not sufficiently monitored to ensure *safely managed* drinking water. Additionally, aspects on governance and infrastructure investment should be included to account for preventative measures. This might be worth considering especially in the context of currently widely established infrastructure, which will require high investments for maintenance and development in the near future [15,16].

Table 3. Targets and core indicators of Sustainable Development Goal 6. Ensure availability and sustainable management of water and sanitation for all [14].

Targets	Indicators
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	6.1.1 Proportion of population using safely managed drinking water services
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	6.2.1 Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	6.3.1 Proportion of domestic and industrial wastewater flows safely treated 6.3.2 Proportion of bodies of water with good ambient water quality
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	6.4.1 Change in water-use efficiency over time 6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources
6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	6.5.1 Degree of integrated water resources management 6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation
6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1 Change in the extent of water-related ecosystems over time
6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	6.a.1 Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan
6.b Support and strengthen the participation of local communities in improving water and sanitation management	6.b.1 Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management

3.2.2. Status Quo of Target 6.1 in Austria

With 99% of Austria's population using safely managed drinking water services [41], a very high level of Indicator 6.1.1 is achieved in Austria (Table 4). Complementary to the population connected to public water supply (Table 4) and according to estimations by the Federal Ministry of Agriculture, Regions and Tourism [50], about 10% of the Austrian population are using self-supplied drinking water (e.g., private wells). The 1% of population not using safely managed drinking water is assumed to mainly consist of a share of the population using self-supply, which, compared to public supply, can be more difficult to manage and monitor and the quality of which cannot be ensure continuously. Self-supply does not lie within the public responsibility and is possibly more vulnerable to climate change. Yet, in some cases, it is preferred over a connection to the public supply (e.g., due to economic reasons or the desire of self-sufficiency). The high percentage of self-supply in specific regions of Austria is mainly caused by low population densities that make this solution more economically feasible. As reflected by the results of detailed drinking water quality monitoring as well as the population's satisfaction with the water quality, water supply service and price/performance ratio, affordability and acceptability of water supply are generally high.

Table 4. Possible complementary indicators for Target 6.1 and available data for Austria. "n.d." indicates that no data for Austria were available, suggesting a potential data gap. "*" denotes complementary data that do not explicitly correspond to a complementary indicator suggested in the screened literature but could be directly linked to one of the critiques expressed and complemented the given information.

6.1.1.	**Proportion of Population Using Safely Managed Drinking Water Services** [1]	**99% [41]**
Category	**Complementary Indicators**	**Available Data for Austria**
Disaggregation	By age/disadvantaged [16]	n.d.
	By gender [16,39]	n.d.
	By income [16,39]	n.d.
	Geographic location [16,51,52]	At least basic services [2]: 100% (rural)/100% (urban) [39]
	By migratory status [18]	n.d.
	By race/ethnicity [18]	n.d.
Accessibility	Water supply at school [16,39]	n.d.
	Water supply at health care facilities [16,39]	n.d.
Availability/equity	Concentration index in the provision of water services (coefficient of inequality in water access ordered by income) [49]	n.d.
	Entropy measures: Measures the detachment of the current distribution of people from different socioeconomic levels without access to current water compared to a completely perfect distribution, where a proportional fraction of people without access is present in each socioeconomic level. [49]	n.d.
	Atkinson index: A normative value, that includes a parameter ε, which "*is linked to a social utility or willingness by individuals to accept a more equal distribution*" [49]. The "*Atkinson index shows the percentage of total Water coverage that a given society would have to forego to have more equal shares of water coverage between socioeconomic levels.*" [49]	n.d.
	Gini-index of piped water access [53]	n.d.
	In-depth questionnaire on WASH (water, sanitation, hygiene) level with household and individual-level indicators between people and households with and without disabilities [25]	n.d.
	WASH access of vulnerable and marginalized groups (persons with special physical needs, users of health facilities, users of educational facilities, users of retirement homes, prisoners, refugees, homeless people, travellers and nomadic communities, people living in housing without water and sanitation, persons without access to water and sanitation in their workplace) using, e.g., Equitable Access Score-card [27]	n.d.
	Female/male perceptions and concerns about the (1) availability; (2) accessibility; (3) quality (cleanliness, hygiene, water for cleaning); and (4) safety for female/male adults/children/elderly/differently abled, of water, sanitation and hygiene services in public places (such as markets, hospitals, tourist places, town squares), by geographical location in the survey area [33,42]	n.d.
	Female/male perceptions and concerns of the (1) availability; (2) accessibility; (3) quality (cleanliness, hygiene, water for cleaning); and (4) safety for female/male adults/children/elderly/differently abled, of water, sanitation and hygiene services in camps for refugees, migrants, asylum seekers and displaced people(s) [33,42]	n.d.

Table 4. *Cont.*

6.1.1.	Proportion of Population Using Safely Managed Drinking Water Services [1]	99% [41]
Category	**Complementary Indicators**	**Available Data for Austria**
Affordability	Average water bill per month in % of average income per month (target value < 4%) [15]	0.8% [54]
	Tariff perception [26]	70% assess the price/performance ratio to be very adequate or adequate [55]
	Population connected to public water supply *	91.8% (in 2016) [56]
Infrastructure	Water-related investment * (target value: 0.6% of GDP [57]) [4]	~247 Mio. €/year investment in drinking water supply (not specifically infrastructure) [54] (~0.05% of GDP) [3] 191 Mio € environmentally relevant investments in water supply at municipal level in 2019 [58] (~0.04% of GDP) [3]
	Age of infrastructure *	1/3 of drinking water pipes is older than 40 years; 12% older than 50 years [54]
Water quality	Water quality of drinking water [8,15]	According to drinking water regulation [59]: excellent quality [60]
	Compliance rate of quality of drinking water according to defined standards *	Microbiological parameters: 99.84% Chemical parameters: 99.9% Indicator parameters: 99.9% (2011–2013) [61]
	Water treatment within the household [26]	n.d.
Acceptability	Satisfaction with the service [26]	60% of respondents are very satisfied [55]
	Water quality perception [26]	90% of respondents assessed the water quality as very good [55]

[1] According to UN Water [14] and the JMP [39], a *safely managed* drinking water source is "located on the premises and available when needed, and free of faecal and priority chemical contamination" [14] (p. 8). [2] Disaggregated data (rural/urban) is only available for Austria for "people using at *least basic* drinking water service" in contrast to the core indicator that assess whether it is beyond that also *safely managed*. [3] Estimated using data on the Austrian GDP [62] and an approximated exchange rate of 1 USD = 0.88 €. [4] The asset class "Water" used in Woetzel et al. [57] is assumed to include sewage infrastructure but is not clearly defined, consequently the corresponding target value can only be used for rough comparison.

In-depth assessment on access to water and sanitation in public spaces and for vulnerable and marginalized groups to acknowledge the Agenda's promise to leave no one behind (LNOB) [63] might be worthwhile. Infrastructure investments should be coordinated with foresight considering the anticipatable investments needed for maintenance and development of the infrastructure in place. Essex et al. [15] suggest an indicator on infrastructure investment using "infrastructure" generically, including, e.g., infrastructure investments in the transport sector. This is specified in the paper presented here using data for the water and sanitation sector.

3.3. Indicators for Target 6.2

3.3.1. Critical Appraisal of Indicators for Target 6.2

Similar to Target 6.1, Target 6.2 has overcome many of the shortcomings of MDG 7C by taking collection, transport and treatment of faecal waste as well as hand washing into account [16]. Ongoing criticism concerning insufficient consideration of hygiene within the core indicators (including menstrual hygiene, food hygiene) [16] is partly being addressed by complementary monitoring [40]. Similar to Target 6.1, aspects of accessibility, affordability, equity and acceptability are not sufficiently covered by the indicator, even more so considering evident gender issues (e.g., menstrual hygiene, safety, equitable fee) and the sensitivity of the topic of personal sanitation across many cultures [26]. Once again, accessibility comprises, besides the household level, also schools, health care facilities and other public spaces [16]. In this respect, the affordability aspect requires access fees to toilets in public spaces to be economically viable without compromising or threatening the users' realization of other human rights. States should "*significantly reduce*" and "*ideally, remove*" [48] (para. 47) access fees for users who rely on these facilities and who cannot afford the fees. The practice of charging for the use of public toilets and not for urinals is highly questionable in terms of gender discrimination [48]. To give *special attention to the needs of women and girls as well as people in vulnerable situations* as outlined in the target, specified data collection (e.g., at individual level) is needed [18,27]. Consultations with vulnerable and marginalized target groups, which include women and people who are transgender, may be required [48] (para. 51). Infrastructure investment as proxy for preventative financing and maintenance are not considered either [15,16].

Finally, as Turman-Bryant et al. [64] (p. 235) emphasize, the Indicator 6.2.1 does not measure sustainability in terms of "*the ability to sustain 'services to ensure lasting benefits'*". Or as Guppy et al. [16] puts it, it does not measure whether the installed sewer systems are "*adequate—operational, reliable and accessible*" (p. 509). In fact, considering the plea of the scientific community to take into account the entire sanitation chain [65,66], the need to strengthen the link between Target 6.2 and Target 6.3 is obvious. Sustainable sanitation systems should "*not only be economically viable, socially acceptable, and technically and institutionally appropriate, they should also protect the environment and the natural resources*" [67] (p. 1). All these aspects, and especially the latter, which includes energy, water, nutrients and other natural resources as well as the degree of recycling and reuse, require consideration from the very beginning of the sanitation chain.

3.3.2. Status Quo of Target 6.2 in Austria

According to the core indicator, which is monitored at household level [14], 100% of the Austrian population are using safely managed sanitation services [41] (Table 5) whereby flushing toilets are prevalent. Around 95% of the population are connected to a sewer system where the wastewater is treated in a wastewater treatment facility with design size of larger than 50 PE (person equivalent). The remaining population is connected to decentralized small wastewater treatment facilities (≤50 PE) [68] or wastewater is collected in cesspits with transport of the wastewater to larger wastewater treatment facilities. Treatment performance is covered by Target 6.3. [69] (p. 11). Within the Joint Monitoring Programme (JMP) by WHO/UNICEF [39] sufficient data are only available at household level. For the hygiene indicator no data are available. Despite the data gap it can be assumed that in Austria access to safely managed sanitation and hygiene in health facilities and schools is widely given. Still, access to toilets in public spaces is often limited to a certain timeframe and/or subject to charges, excluding people who cannot afford it. The so-called *Euro-Key* is handed out to people with disabilities to enter a number of public toilets with barrier-free access whenever needed [70]. To enable homeless people to access toilets free of charge social workers in Vienna, the capital of Austria, are handing out chips to enter public toilets at specific locations [71]. Detailed data and evaluation as, e.g., suggested by Ezbakhe et al. [27] to assess and assure access to safely managed sanitation and hygiene for marginalised groups such as homeless and elderly people or travellers are currently not available. In-depth, gender-sensitive assessment of sanitation services in public places [42], and menstrual hygiene and health [40] could help to draw a more detailed picture on where targeted measures might be necessary to give the aspired towards attention to women and girls and those in vulnerable situations.

Ultimately, to enhance sustainable sanitation along the entire sanitation chain, all aspects of sustainability need to be considered, starting from the user interface, i.e., the toilet, or, in case of SDG 6, Target 6.2. While connection to wastewater treatment facilities is widely established, high costs for rehabilitation and maintenance of the sewer infrastructure can be expected within the next years, particularly considering that current rehabilitation rates are far too low [72]. The yearly investments in wastewater management of 350 Mio € for the years 2014–2016 (Table 5) comprise, besides the construction and rehabilitation of infrastructure itself, also the development and extension of databases for existing infrastructure (mainly digital sewer registers) [72].

Table 5. Possible complementary indicators for Target 6.2 and available data for Austria. "n.d." indicates that no data for Austria were available, suggesting a potential data gap. "*" denotes complementary data that do not explicitly correspond to a complementary indicator suggested in the screened literature but could be directly linked to one of the critiques expressed and complemented the given information.

6.2.1.	**Proportion of Population Using (a) Safely Managed Sanitation Services**	**100% [41] [1]**
	and (b) a Hand-Washing Facility with Soap and Water	**n.d.**
Category	**Complementary Indicators**	**Available Data for Austria**
Disaggregation	By gender: Share of total population not having indoor flushing toilet for the sole use of their household (male/female) [16,39]	0.8/0.9% (2020) [73]
	By gender: Share of total population having neither a bath, nor a shower in their dwelling (male/female) [16,39]	0.6/0.7% (2020) [74]
	By income: Population having neither a bath, nor a shower, nor indoor flushing toilet in their household by poverty status (below/above 60% of median equivalised income) [16,39]	0.4/0.6% (2020) [75]
	Disaggregation by age/disadvantaged [16,39]	n.d.
	Geographic location [16,39,51,52]	99.20 (rural)/99.95 (urban) (2020) [39] [2]
	Migratory status [18]	n.d.
	Race/ethnicity [18]	n.d.
Accessibility	Sanitation service at school [16,39]	n.d.
	Sanitation service at health care facilities [16,39]	insufficient data [39]
Availability/equity/quality	In-depth questionnaire on WASH (water, sanitation, hygiene) level with household and individual-level indicators between people and households with and without disabilities [25]	n.d.
	WASH access of vulnerable and marginalized groups using, e.g., Equitable Access Score-card [27]	n.d.
	Female/male perceptions and concerns about the (1) availability; (2) accessibility; (3) quality (cleanliness, hygiene, water for cleaning); and (4) safety for female/male adults/children/elderly/differently abled, of water, sanitation and hygiene services in public places (such as markets, hospitals, tourist places, town squares), by geographical location in the survey area [33,42]	n.d.
	Female/male perceptions and concerns of the (1) availability; (2) accessibility; (3) quality (cleanliness, hygiene, water for cleaning); and (4) safety for female/male adults/children/elderly/differently abled, of water, sanitation and hygiene services in camps for refugees, migrants, asylum seekers and displaced people(s) [33,42]	n.d.
Acceptability	Conditions of privacy in the latrine [26] Conditions of comfort in the latrine [26] Satisfaction with the location of the facility [26]	n.d. n.d. n.d.
Affordability	Household contribution to construction of the facility [26] Investment to construct a sanitation facility [26] Reasons for not having a latrine: insufficient money [26] Average wastewater fee in % of average income	n.d. n.d. n.d. 1.3% [72]
Hygiene	Private place to wash and change [40] Use of menstrual materials (reusable/singe-use) [40] Participation in activities during menstruation [40] Awareness of menstruation before menarche [40] Prevalence of menstrual taboos amongst the target population [40]	n.d. n.d. n.d. n.d. n.d.
Infrastructure	Infrastructure investment (target value: 3.8% of GDP) [15,57] [3]	Transport infrastructure investment and maintenance spending [3]: 2.3 Mrd € (2019) [76] (~0.5% of GDP) [4]
	Investment in wastewater management (target value for asset class "Water" [5]: 0.6% of GDP)	350 Mio €/a (2014–2016) [72] (~0.08% of GDP)
	Age of infrastructure [15]	11% older than 50 years [72]
	Status class of sewage system *	32% of total sewage system in need for action to be rehabilitated (immediate to long-term) [72]
	Estimation of percentage of private house connections that exhibit defects *	70% [72]
	Rehabilitation rate of sewage system (required according to ÖWAV [72]: 1.8%) *	~0.14%(2016–2018) [72]

[1] According to UN Water [14] the core indicator is monitored at household level. [2] Differences compared to the aggregated value [41] are rounding differences. [3] Infrastructure investment as outlined in Essex et al. [15] and the respective target value of 3.8% of GDP according to Woetzel et al. [57] refers to total infrastructure investment, yet the data source referenced in Essex et al. [15] is limited to transport infrastructure investment and maintenance spending and does not include e.g., water, power and telecom infrastructure. [4] Estimated using data on the Austrian GDP [62] and an approximated exchange rate of 1 USD = 0.88 €. [5] The asset class "Water" used in Woetzel et al. [57] is assumed to include sewage infrastructure but is not clearly defined, consequently, the corresponding target value can only be used for rough comparison.

3.4. Indicators for Target 6.3

3.4.1. Critical Appraisal of Indicators for Target 6.3

Understandably, using a single index to describe water quality as done using indicator 6.3.1 is desirable for the global monitoring framework of the SDGs. However, it might be interpreted divergently by different countries corresponding to their national regulations rather than producing a globally comparable indicator. Yet, it does not allow for in-depth policy making at national level as water quality assessment requires the use of a multitude of parameters [8] and their amalgamation is criticized to be "*scientifically questionable*" [20] (p. 4).

Recycling and safe reuse as mentioned in the target refer to water recycling (e.g., for industrial use) and reuse (e.g., for irrigation in agriculture or parks) [14]. These aspects are not covered by the indicators and the need for a corresponding (sub-)indicator for the assessment of recycling and reuse potential is emphasized [13], [14] (p. 14), [77] (p. 58). In general, a lack of monitoring of circular economy of water is identified [15]. Monitoring of agricultural wastewater and emissions is not clearly described. Yet agriculture is one of the major contributors to diffuse pollution in many countries, making it both important but also difficult to measure [28,69]. This underlines the interlinkages with Target 2.4 on *sustainable agriculture* [1,8]. Others highlight the link between solid waste management (Target 12.5 on *reduction of waste generation*) and pollution of water bodies in urban areas [14,15,78]. While point source pollution has been widely addressed in many countries of the Global North, diffuse pollution sources still pose a problem [28]. Indicator 6.3.2 on water quality of water bodies measures the combined impact of all pollution sources. For more disaggregated assessment separate monitoring of, e.g., surface water quality, groundwater quality and ecological status are recommended [15]. EUROSTAT employs four indicators to assess Target 6.3, namely, biochemical oxygen demand in rivers [64], nitrate in groundwater, phosphate in rivers and bathing sites with excellent water quality by locality [79]. They are used as proxy for water quality but, rather than a countrywide average values of various measurement stations, particularly the former three would require spatial disaggregation to be useful for policy making.

3.4.2. Status Quo of Target 6.3 in Austria

In Austria, all sewage treatment plants (except the ones in extreme locations) are required to fulfil biological treatment as well as nitrification according to national regulations [80]. Consequently, wastewater of the population connected to the public sewage system (~95%) is undergoing at least secondary wastewater treatment (Tables 5 and 6). In all plants larger 1000 and 5000 PE also phosphorus and nitrogen, respectively, are removed. Available data for wastewater treatment plants (>50 PE) show a removal efficiency of 81% for total nitrogen and 91% for total phosphorus (Table 6) [81]. The remaining wastewater is treated in around 27,500 small wastewater treatment plants (≤50 PE) or collected in cesspits [68,82]. According to Langergraber et al. [82], about 6000 small wastewater treatment plants have only primary treatment, mainly three-chamber septic tanks constructed before 1990, which at that time were state-of-the-art. Assuming a utilization rate of the small wastewater treatment plants of 80%, the wastewater of a maximum of 0.4% of the population is not treated according to the legal requirements.

Table 6. Possible complementary indicators for Target 6.3 and available data for Austria. "n.d." indicates that no data for Austria were available, suggesting a potential data gap. "*" denotes complementary data that do not explicitly correspond to a complementary indicator suggested in the screened literature but could be directly linked to one of the critiques expressed and complemented the given information.

6.3.1	**Proportion of Domestic and Industrial Wastewater Flows Safely Treated**	**99% [41]**
6.3.2	**Proportion of Bodies of Water with Good Ambient Water Quality**	**82% [41]**
Category	**Complementary Indicators**	**Available Data for Austria**
Single index	Secondary wastewater treatment [1] (target: 100%) [15]	99.6% including wastewater treatment plant with PE < 50 [68,82]
	Removal efficiency (for >50 PE)	Biological oxygen demand (BOD_5): 99%; Chemical oxygen demand (COD): 95% [81]
	Tertiary wastewater treatment [2] (target: 100% [15]): Removal efficiency (for >50 PE)	Nitrogen: 81% [81]
		Phosphorus: 91% [81]

Table 6. *Cont.*

6.3.1	Proportion of Domestic and Industrial Wastewater Flows Safely Treated	99% [41]
6.3.2	Proportion of Bodies of Water with Good Ambient Water Quality	82% [41]
Category	**Complementary Indicators**	**Available Data for Austria**
Water footprint	Grey water footprint per water resources system vs. maximum sustainable grey water footprint in that system [83]	n.d.
	Total grey water footprint of national production *	1033 Mm^3/a (1996–2005) [84]
	Total grey water footprint of national consumption *	2936.2 Mm^3/a (1996–2005) [84]
		Internal: 748.7 Mm^3/a (1996–2005) [84]
		External: 2187.5 Mm^3/a (1996–2005) [84]
	Total grey water footprint per capita *	998 L/cap/d (1996–2005) based on [84]
		Internal: 744 L/cap/d (1996–2005) based on [84]
		External: 254 L/cap/d (1996–2005) based on [84]
Nutrient and energy recovery and recycling	(Gross) nutrient balance: as the difference between the nutrient inputs entering a farming system (mainly livestock manure and fertilisers) and the nutrient outputs leaving the system (the uptake of nutrients for crop and pasture production) *	Nitrogen: 32 kg/ha (2016), 46 kg/ha (2017) Phosphorus: −1 kg/ha (2016), 2 kg/ha (2017) [85]
	Nutrient recovery (%) (target 100%) [15]	27% of phosphorus from sewage sludge and 3% contained in animal waste are recovered [86]
	Wastewater to energy (target 100%) [15]	Heat potential: 3375 GWh/a (~40% of the thermal energy generated in plants without combined heat and power supply; potential reduction of 17% of the Austrian global warming potential for room heating) potential for power generation: 115.5 GWh/a [87]
	Awareness about wastewater (as part of wastewater reuse effectiveness index) [13]	n.d.
	Treatment/use of sewage sludge *	21% agricultural reuse; 46% thermal treatment and use of waste heat; 33% other treatment (e.g., composting, mechanical-biological treatment or humification) [88]
Energy intensity	Average specific energy consumption of wastewater treatment plant *	~44 kWh/PE_{120}/a (>50 PE ad w/o the WWTP in Vienna) [72]
	Share of self-produced electric power at wastewater treatment plants *	37% (from various sources including photovoltaic, digester and natural gas) [89]
Interlinkages	Crops grown under wastewater (as part of wastewater reuse effectiveness index) [13]	n.d.
	Area irrigated by wastewater (as part of wastewater reuse effectiveness index) [13]	n.d.
	People depending on wastewater (as part of wastewater reuse effectiveness index) [13]	n.d.
	Area under organic farming in percent of total agricultural land	25.33 (2019) [90]
	Municipal solid waste collected (%) (target: 100%) [15] [3]	100% (2019) [91]
	Municipal solid waste recycled (%) (target: 65%) [15]	Close to 60% (2019) [91]
	Municipal solid waste to energy (%) (target: 100%) [15]	7% of total waste (2019) [91]
Water quality	Surface water quality (target according to the EU Water Framework Directive (WFD) [92]: at least good chemical status for all water bodies) [15]	At least good: streams (in % of length): 76.7%; 57 of 62 natural lakes (>50 ha) [93]
	Groundwater quality (target according to the WFD [92]: at least good chemical status for all water bodies) [15]	4 of 138 groundwater bodies fail the good chemical water status [93]
	Ecological water quality [15] (ecological status or ecological potential) (target according to the WFD [92]: at least good ecological status or ecological potential for all water bodies) [15]	At least good: streams (in % of length): 38.5%; 55 of 62 lakes (>50 ha) [93]
	Pesticides in the water environment [8]	Groundwater: 40 out of 1960 measurement points are at risk [93]
	Biochemical oxygen demand in rivers [68]	1.68 mg O_2/L (2018) [79]
	Nitrate in groundwater [93]	21.92 mg/L (2018) [79]; details are available [93,94]
	Phosphate in rivers [93]	0.032 mg/L (2018) [79]; details are available [93,94]
	Number of monitoring sites in rivers with respective status class of physicochemical parameters	Very good/good: 70 (78%) Less than good: 20 (22%) [94]
	Bathing sites with excellent water quality [93]	Excellent: 255 (97.7%); Good: 5 (1.9%); Not classified: 1 (0.4%) [95]

[1] Removal of solids and organic matter. [2] Removal of nitrogen and phosphorus. [3] According to supplementary material in Essex et al. [15].

A potential complementary indicator for Target 6.3 is the grey water footprint [83]. It is an "*indicator of the degree of freshwater pollution and is defined as the volume of freshwater that is required to assimilate the load of pollutants based on existing ambient water quality standards*" [84] (p 12). The grey water footprint underlines the huge external impact on water pollution of Austrian consumption (Table 6).

Recovery potential of phosphorus and energy (as heat) from wastewater is estimated to be high [87]. No specific data for nitrogen recovery from wastewater in Austria are available. In the future, 65–85% of sewage sludge is intended to be brought to phosphorus recovery from incineration ash. Still, detailed planning of the corresponding infrastructure and assessment of different options for phosphorus recovery considering costs and possible environmental impacts are necessary [72,96]. To utilize the energy recovery potential, integrating spatial planning and targeted participation of stakeholders to broaden awareness and acceptance of wastewater as energy source appear to be crucial [87,97].

As indicated by several critics, an amalgamated index for water quality is not sufficient for national policy making. With the national implementation of the European Water Framework Directive (WFD) [93] an in-depth assessment of the chemical and ecological water status as well as pesticides and other chemical residues in the water environment and corresponding risks is available. Various drivers (e.g., climate change, agriculture and land use) as well as pressures (e.g., nutrients and pesticides) are assessed in detail and corresponding maps as well as a catalogue of measures are presented [93]. Special attention should be given to groundwater protection, as it is the only source for drinking water in Austria used so far [98]. Following targeted measures over the last years, qualitative improvements of groundwater were detectable. Changing environmental conditions like climate change and the continuous need for reduction of pollutant influx make further research and adaptation of analysis methods necessary. Measures for further reduction of critical nitrogen pollution are especially necessary in east Austria, where agricultural practice is intensive and precipitation is low. The number of measuring points at risk due to pesticides increased compared to the monitoring report in 2009. Impacts of increasing water temperatures on chemical and biological conditions in groundwater bodies as well as microbiological activity are still uncertain [93,99]. Besides erosion from agricultural areas, other relevant sources of diffuse pollution of surface water bodies include inflows from sealed surfaces, particularly traffic areas, and from historical mining activities [93]. In several other countries, regulations on a follow-up treatment step to remove trace substances (4th treatment stage) are debated to protect surface water bodies that are often the main drinking water source. In Austria, the drinking water source is about 45% from springs and about 55% from wells [98], surface water is not used as a source for drinking water. Thus, regulations requiring a 4th treatment stage are quite unlikely in Austria. In any case, due to high technical and financial effort for the introduction of such a treatment step, general prevention of trace substances appears to be the preferable solution [100].

3.5. Indicators for Target 6.4

3.5.1. Critical Appraisal of Indicators for Target 6.4

The indicators for Target 6.4 give overall information on water use efficiency and the level of water stress. However, the local situation as well as the time factor both play an essential role in securing water supply. Using a mean for the whole country and long time periods is not meaningful, and spatial, temporal as well as sectoral disaggregation of both indicators is strongly encouraged [28,101–103]. In addition to disaggregation the use of additional indicators to measure inequality is recommended [104]. Furthermore, Baubekova and Kvasha [105] stress that long-term data collection will be especially relevant for Indicator 6.4.1 to track change over time and that data gaps are persisting.

Referencing water consumption to GDP as applied with Indicator 6.4.1 is not relevant for public drinking water supply. Indicators on the status of the (public) infrastructure might support estimation of water use efficiency within this sector [15]. While the indicator is more suitable to inform on industrial and agricultural water use, Indicator 6.4.1 does this from a purely economic perspective. It does neither monitor possible socioeconomic benefits (e.g., jobs, income) [53], productivity (considering energy or food production) [16] nor efficiency in the use of rainwater (so-called green water), e.g., in rainfed agriculture [16,83]. Hellegers and van Halsema [102] exemplify that the current indicator is based on the rationale of decoupling economic growth and ignores environmental and social aspects of water use. They emphasize that the indicator leaves economic growth unchallenged and favours increased water withdrawal serving economic efficiency to the detriment of environmental sustainability and water resources. Another flaw is its sensitivity to changes in the allocation of water withdrawal away from agriculture to services and industry. The simplest path to increasing the indicator would consequently be an economic shift away from agriculture to other sectors, which ignores the indispensability of water for agriculture and ultimately food security. It further does not allow to track global trade and embedded water resources [102]. To monitor these, indicators on virtual water flows and the water footprint are recommended [20,28,83,106]. Hoekstra et al. [83] add that SDG 6 omits to introduce a target on fair and equitable sharing of water, admitting that research on such a target might be difficult due to its normative character. They emphasize that this gap will probably lead to a persistent unbalance of proposed solutions [83].

Vanham et al. [28] did a detailed evaluation on Indicator 6.4.2 and identify several essential elements of the metric. Besides the already mentioned importance of temporal and spatial disaggregation, they illustrate the need to consider both gross but also net water abstraction (the blue water footprint) to understand water stress. This goes hand in hand with the critique expressed by Guppy et al. [16] that withdrawal and abstraction are used synonymously and that cross- as well as international consensus on some measures (e.g., outflows and return flows) is not well established. Vanham et al. [28] further underline that by incorporating environmental flow requirements (EFR), a significant gap of the MDGs has been addressed, but that a need for catchment-specific EFR based on natural conditions remains. In addition to accounting for renewable surface water and groundwater resources as renewable water availability, Vanham et al. [28] recommend including other alternative available water resources such as fossil groundwater and desalinated water. Taking into account (artificial) surface water storage (including corresponding evaporation) and groundwater storage is recommended as well. Emphasis is also given to water quality as an integral part of water stress quantification and consequently to the need to create a link to Target 6.3. Ultimately, Vanham et al. [28] exhibit the relevance of the connection of blue and green water in water assessment, as changes in green water flow and retention, e.g., due to altered land use, can impact availability of blue water downstream or, with a time lag, local rainfall [28]. Guppy et al. [16] argue that while calculation of water stress is clear, the indicator still lacks monitoring of the number of people actually affected by water scarcity for particular or vulnerable parts of the population. Bhaduri et al. [20] recommend further research in the assessment of potential lack of investments or human capacity for water demand satisfaction as described by economic water scarcity, an aspect of water scarcity for which Vallino et al. [107] suggest using the Indicator 6.5.1 on integrated water resources management (IWRM) as proxy.

Several authors recommend a more integrative assessment of water scarcity and security. To evaluate SDG 6 as a whole, analyse its interlinkages with other SDGs (in particular SDG 2 and SDG 7 within the water-energy-food (WEF) nexus) and consider additional aspects like adaptative capacity, partly complex indices are introduced [101,103,108,109]. While the introduction of these indicators is doubtlessly often justified and can be valuable, they are not included in the scope of this study as they mostly require weighting, consequently enhance subjectivity and may produce inconsistent results, such as in the context of the scarcity weighted water footprint [110].

3.5.2. Status Quo of Target 6.4 in Austria

While the overall quantitative status of water resources in Austria exceed water demand by far (Table 7), local and temporal shortfalls, e.g., due to dry periods or peak demands are possible [99] and make disaggregated assessment especially relevant for Target 6.4.

A rather simple indicator for water losses, such as the water leakage (%) suggested by Essex et al. [15], might be attractive for a country-to-country comparison. Results from a benchmarking project in the water supply sector in Austria, however, demonstrate, that for in-depth interpretation of leakage data a number of additional performance indicators like "*real losses per mains length*" or "*real losses per connection and day*" should be monitored [111] (p. 9). Data for Austria concerning these are available but rather old. Optimization of maintenance measures for the water supply infrastructure, in dependence of the state of the pipe network and corresponding water losses are recommended [112].

Table 7. Possible complementary indicators for Target 6.4 and available data for Austria. "n.d." indicates that no data for Austria were available, suggesting a potential data gap. "*" denotes complementary data that do not explicitly correspond to a complementary indicator suggested in the screened literature but could be directly linked to one of the critiques expressed and complemented the given information.

6.4.1	**Change in Water-Use Efficiency over Time**	**103 $/m^3 [41]**
6.4.2	**Level of Water Stress: Freshwater Withdrawal as a Proportion of Available Freshwater Resources**	**9.64% [113]**
Category	**Complementary Indicators**	**Available Data for Austria**
	(Residential) per capita water use [53,104]	126 L/capita/day [98]
Socioeconomic aspects	Jobs per million cubic metre in heavily water-dependent sectors (Mm^3/a) [53]	n.d.
	Change in the ratio of gross economic value added by irrigated and rainfed agriculture to the volume of water consumed by rainfed and irrigated agriculture over time [102]	n.d.
	Yield per unit of water use/water intensity of food production [52,108,114,115]	n.d.
	Annual freshwater demand for agriculture [52]	124 Mm^3/a [98]
	Annual freshwater demand of industry *	2210 Mm^3/a [98]
	Annual freshwater demand of water supply *	753 Mm^3/a [98]
	Energy produced per unit of water used for energy production (productivity) [14,108]	n.d.
	Energy intensity of water supply *	0.33 kWh/m^3 [54]
Efficiency	Water leakage [15]	~14% of network supply [98] (p. 201)
	Municipal water losses [53]	n.d.
Water scarcity	Water scarcity/Water exploitation index (WEI+) [15,28] values >20% are widely accepted to imply that water resources are under stress [15,116]	For Austria: 1.7% (2016) [1] [98]
	Ground water depletion (Mm^3/a) [101,103]	826 Mm^3/a which corresponds to about 16% of the available groundwater resources are used by extraction from wells, [98]
	Quantitative status of groundwater bodies near the surface *	All show a good status, but two exhibit a risk to fail this status in 2027 [98]
Disaggregation	Level of water stress for river basin districts *	WEI+ for the Austrian part of the river basin Rhine: 0.39% and of the river basin Danube (excl. March): 3.57% (2016) [98]
	Intensity of use of groundwater bodies	Detailed assessment at groundwater level available [98]
	Spatially disaggregated water use efficiency [102,103]	n.d.
Equity	Gini index of water use [104]	n.d.

Table 7. *Cont.*

6.4.1	Change in Water-Use Efficiency over Time	103 $/m³ [41]
6.4.2	**Level of Water Stress: Freshwater Withdrawal as a Proportion of Available Freshwater Resources**	**9.64% [113]**
Category	**Complementary Indicators**	**Available Data for Austria**
Water footprint	Blue water footprint of national consumption/net water abstraction [20,28,83]	795.3 Mm³/a (1996–2005) [84]
		Internal: 130.7 Mm³/a (1996–2005) [84]
		External: 664.6 Mm³/a (1996–2005) [84]
	Total blue water footprint per capita *	271 L/cap/d (1996–2005) based on [84]
		Internal: 45 L/cap/d (1996–2005) based on [84]
		External: 226 L/cap/d (1996–2005) based on [84]
	Green water footprint [20,28,83]	Of national consumption 9140 Mm³/a (1996–2005) [84]
		Internal: 3193 Mm³/a (1996–2005) [84];
		External: 5947 Mm³/a (1996–2005) [84];
	Total green water footprint per capita *	3108 L/cap/d (1996–2005) based on [84]
		Internal: 1086 L/cap/d (1996–2005) based on [84]
		External: 2022 L/cap/d (1996–2005) based on [84]
	Total water footprint per capita *	4738 L/cap/d [117] [2]
Availability	Proportion of available freshwater resources per capita [108]	Available groundwater resources: ~5115 Mm³/a [98]

[1] Differences compared to Indicator 6.4.2 originate from a different data basis being used and the quantification of the WEI+, that in contrast to the SDG indicator takes into account return flows [93]. [2] Compared to data from a partial update of the total water footprint in Neunteufel et al. [117] using data from 2014–2018.

For quantitative assessment of water resources and related water stress, a detailed, up-to-date data basis is available for Austria [98]. Besides the assessment of the quantitative status of groundwater bodies and their intensity of use, it includes disaggregation of data on water demand and available resources at the level of groundwater bodies. Further estimations of the water demand in peak years as well as scenarios for 2050 are described. Industrial water demand accounts for 70% of the total water demand, the majority of it is used for cooling purposes, withdrawn from surface water bodies (84%) and returned nearby as return flow. Water demand for water supply is estimated to account for 24% of the total water demand, followed by agriculture with only 4%. While all groundwater bodies near surface currently reach at least good quantitative status, two are at risk of failing this status in 2027. To fully grasp local challenges within the interplay of water demand and water resources (e.g., more frequent dry periods due to climate change, peak demands) and to set corresponding counter measures, the need for more detailed spatially and temporally disaggregated assessment is emphasized. Research on water withdrawal for cooling and water temperature is recommended [98].

Besides impacts on domestic water resources described by the internal water footprint, the external water footprint can serve as proxy for impacts of Austrian consumption on water resources abroad. It illustrates that about two-thirds (68%) of Austrian water consumption occurs in areas across the border [118].

3.6. Indicators for Target 6.5

3.6.1. Critical Appraisal of Indicators for Target 6.5

With various definitions existing for IWRM and due to its processual character, the possibility to develop a practically applicable indicator that actually reflects the real situation is called into question [20]. Similarly, Bartram et al. [17] find the target to concern rather a management approach and resemble an MoI.

Varady et al. [30] discuss the failure of IWRM to deal with complexity and uncertainty and the lack of a clear goal of the concept. As a remedy they suggest combining IWRM with water security and adaptive management approaches. The former shall provide a framework with broad goals and the possibility to measure progress while the latter should enable iteratively re-evaluating these goals and fostering adaptive capacity via participation, science-policy dialogs and social learning [30]. Other critics identify similar aspects not to be sufficiently covered like resilience or adaptability, but also vulnerability, which appear increasingly important, particularly in light of stressors such as climate change or population movements [15,17,119].

Various authors underline the implicit water centricity and/or the missing emphasis of interlinkages with and by other SDGs; often this is addressed using a nexus approach, most famously the WEF nexus [17,30,52,115,120–123] but also amending it with, e.g., ecosystems [124]. While doubtlessly important, the suggested composite indices were not focus of this paper and therefore only explicitly water-related indicators were included.

Although Indicator 6.5.1 and its assessment are found to make a significant contribution to refining and enhancing the methodology to assess IWRM and pertinent key aspects worldwide, some challenges remain and various amendments are suggested [125].

As the assessment is survey-based, ensuring objectivity, transparency and comparability of the results is demanding and requires sufficient and diverse stakeholder involvement and transparent documentation (e.g., reporting on the questionnaire filling procedure, narrative clarifications and reasoning of the scoring).

While the indicators questionnaire is organized along the categories enabling environment, institutions and participation, management instruments and financing, critics suggest other approaches for structuring to allow for a more comprehensive and integrative assessment *at all levels*, as mentioned in the target. Benson et al. [120], for example, recommend assessing IWRM along the dimensions integration, scale, institutions, participation, economic valuation, equity and environmental/ecological protection and present corresponding quantitative indicators that should in addition support the implementation of other SDGs. Bertule et al. [125] analyse the indicators questionnaire using the OECD Principles on Water Governance [126]. They find that Principle 8 (promotion of innovative governance) and 9 (integrity and transparency) are not mentioned explicitly and that Principle 11 (manage trade-offs, across users, rural and urban, and generations) as well as 12 (monitoring and evaluation) are only partially addressed. Rather than introducing a new structure or indicator, they suggest amending and adapting the existing questionnaire to ensure comparability and continuity, an approach which is also supported by Guppy et al. [16].

A major critique concerning Indicator 6.5.2 is it being only quantitative and of a "*binary nature*" [31] (p. 1) leading consequently to a lack of ability to reflect on political complexity of transboundary water cooperation and to diverse interpretations and results [20,29,31,120,127].

The belated introduction of the four operationality criteria is generally appreciated and recognized to partly alleviate this problem. For an arrangement to be operational and account for this indicator it has to comprise a joint body, regular (at least once per year) formal communication and data exchange as well as coordinated water management plan(s) or joint objectives [14] (p. 25). Still, the criteria do not define the quality or phase of operation of the arrangements sufficiently, leaving out several important aspects such as the ability to adapt to future uncertainties, financial resilience [119], equity and power dynamics [127–129], allocation, water quality, environmental protection and conflict resolution [31]. In response to this, clarification of the definition of arrangements for water cooperation is suggested, using, e.g., disaggregation and amendments of the operationality criteria [31] or introducing water cooperation scales to cover different arrangement phases [31,119,128].

Other issues that are mentioned are the difficulty to reflect and compare arrangements at different scales (e.g., at sub-basin level or even just part of it) [31,127], a false bias between small and large basins due to the use of area as metric [31,120], the need to report the type of data exchanged [130] and a lack of measuring team interdependence as factor to facilitate cooperation [127].

3.6.2. Status Quo of Target 6.5 in Austria

As apparent in Table 8 many indicators or sub-indicators as part of indices are recommended, but readily available data for these indicators are partly sparse. The IWRM level in Austria is generally estimated to be quite high. A closer look at the dimensions assessed in the indicators' questionnaire in 2020 shows that financing is lagging behind but increased compared to 2017 [41], while enabling environment and management instruments starting from a quite high level decreased within the same period. With the national water management plan [93], the WFD [92] is transposed into national law. It presents a detailed assessment and management plan of water bodies, but some deficits in the practical implementation to reach the ambitious goals can be identified. These include integrated and coordinated land use management with regard to the water balance (e.g., to halt soil sealing and to optimise urban water cycles), participation of the public and private sector, consideration of spatial and temporal differences in water availability for sustainable and efficient water resource management (e.g., irrigation of agricultural land), financing of water resource infrastructure and for IWRM in general and fragmented responsibilities. Additionally, preservations of wetlands and floodplains has not been given enough consideration to date. Trade-offs between drinking water supply, agriculture, hydropower and cooling for industry will most probably increase in the future and measures to balance these need to be discussed [100]. Within the national water management plan [93] hydro-morphological status and diffuse pollution of water bodies are identified as major deficits.

Table 8. Possible complementary indicators for Target 6.5 and available data for Austria. "n.d." indicates that no data for Austria were available, suggesting a potential data gap. "*" denotes complementary data that do not explicitly correspond to a complementary indicator suggested in the screened literature but could be directly linked to one of the critiques expressed and complemented the given information.

6.5.1	**Degree of Integrated Water Resources Management**	**91% [41]**
6.5.2	**Proportion of Transboundary Basin Area with an Operational Arrangement for Water Cooperation**	**100% [41]**
Category	**Complementary Indicators**	**Available Data for Austria**
Interlinkage with Target 6.3	Municipal solid waste recycled (%) [15]	see Target 6.3 (Table 6)
	Municipal solid waste collected (%) [15]	
	Municipal solid waste to energy (%) [15]	
	Crops grown under wastewater (% of subsistence crops) (as part of wastewater reuse effectiveness index) [13]	
	Area irrigated by wastewater (%) (as part of wastewater reuse effectiveness index) [13]	
	Awareness about wastewater (%) (as part of wastewater reuse effectiveness index) [13]	
	People depending on wastewater (%) (as part of wastewater reuse effectiveness index) [13]	
	Water quality index (Target in the Environmental Performance Index: 100 [131]) [101,120]	75.85 (2008) [131]
Interlinkage with Target 6.4	Jobs per million cubic metres in heavily water-dependent sectors (Mm^3/a) [53]	see Target 6.4 (Table 7)
	Change in the ratio of gross economic value added by irrigated and rainfed agriculture to the volume of water consumed by rainfed and irrigated agriculture over time [102]	
	Yield per unit of water use/water intensity of food production [52,108,114,115]	
	Energy produced per unit of water used for energy production (productivity) [108]	
	Water leakage [15]	
	Municipal water losses [53]	
	Energy intensity of water production [115]	
	Annual freshwater withdrawal for agriculture [52]	
	Green water footprint [28,83]	
	Water scarcity index [101,120]	n.d.
	Water productivity index [120]	n.d.

Table 8. *Cont.*

6.5.1	**Degree of Integrated Water Resources Management**	**91% [41]**
6.5.2	**Proportion of Transboundary Basin Area with an Operational Arrangement for Water Cooperation**	**100% [41]**
Category	**Complementary Indicators**	**Available Data for Austria**
Participation	Environmental democracy index [120]	n.d.
	Presence and nature of procedures for participation by female/male members of local communities in decision-making in transboundary water management; number and nature of gender-specific decisions/actions as a result of this participation [42] [2]	n.d.
Gender and equity	Gender development index [120]	n.d.
	Percentage of national, sub-national, sectoral budget allocations, and procedures for integrating gender concerns in water policy frameworks [33,42] [2]	n.d.
	Measures for creating public awareness regarding gender-specific content in water policy frameworks; evidence of implementation of measures [33,42] [2]	n.d.
	Number of female/male staff in different job positions (levels), job field, and salaries (scales) in (a) national ministries that deal with water resources, and (b) in public/private utilities and commissions for water-related services [33,42] [2]	n.d.
Ecological protection	Global environmental flow requirement index [120]	Detailed assessment of residual water flows is available [93]
Governance	World governance index [120]	Set of (sub-)indicators available [132,133]
	Tertiary education attainment (considered as essential for good water governance by Essex et al. [15]; target: 40% of 25–64-year-olds) [15]	30–34-year-olds: 41.6 (2020) [134]
Innovation	Eco-innovation index based on 16 sub-indicators, complements other measurement approaches of innovativeness and aims to promote a holistic view on economic, environmental and social performance (EU average = 100) *	130 (2019) [135]
Vulnerability and resilience	Flood frequency index [101]	Country scale flood frequency during 1985–2003 [136]
	Drought index [101]	0.5° spatial resolution; Yearly value of 2012 available [137]
	Flood vulnerability (target: low risk) [15]	Annual flood affected population: 7163 [138]
	Population potentially affected in flood risk areas	40% (2015) [139]
	Estimated annual average per-capita-expenditure on flood protection	41 €/a [139]
	CO_2 emissions [15] (target: reducing greenhouse gas emissions from 1990 levels by 20% until 2020 and by 55% until 2030) [1]	GHG emissions (2019): 79.8 Mio t CO_2-equivalent (+1.8% compared to 1990 levels) [140]
	Renewable energy (% of total) [15] (target for Austria in 2020: 34% [141])	36.5% (2020) of gross final energy consumption in Austria [142]
	Notre Dame Readiness Index (summarizes a country's vulnerability to climate change; target: 100) [15]	71.7 (2019) [143]
Bias due to area as metric	Proportion of volume of water with an operational arrangement for water cooperation [31]	n.d.
	Proportion of people dependent on the resource with an operational arrangement for water cooperation [31]	n.d.
Complexity of transboundary water cooperation	Scales for water cooperation (e.g., Twins) [119]	n.d.
	Transboundary legal frameworks (target: very low risk ~ The basin legal framework is guided by key principles of international water law to a very strong degree) [15,101,144]	Danube and Rhine: Very low, Elbe: High [144]
	Transboundary political tensions (target: very low risk ~ The levels of potential hydro-political tension due to basin development in absence of institutional capacity are very low) [101]	Danube and Elbe: Moderate; Rhine: Very low [144]
	Hydro-political risk: random forest model based on national power; governance; economic wealth; economic dependence on agriculture; international treaties in the basin, population density; population in rural areas; water availability; precipitation stress: yearly precipitation (min = 0; max = 100) [29]	Likelihood of hydro-political issues: Danube: 0.499; Rhine: 0.124; Elbe: 0.167 [29]

[1] Essex et al. [15] (supplementary material) provided a target of 40% reduction of GHG emissions (from 1990 levels) according to the EU targets that were valid when published. These were raised to a reduction of 55% (from 1990 levels) by 2030 in December 2020 [140]. [2] Exemplary selection from a comprehensive set of more than a hundred indicators on water and gender issues provided within the UNESCO WWAP Toolkit [33].

Austria is found to be particularly exposed to flood risks, which fostered political support to take risk reduction measures. Risk maps and risk management plans according to the European Floods Directive [145] are available [139] and flood risks, vulnerability and corresponding stormwater management are continuing to be subject of research [146–149], an imperative considering that natural hazards like flooding are expected to intensify due to climate change [139,150].

Transboundary arrangements for water cooperation (Indicator 6.5.2) are well established for all river basins in Austria. International Commissions for the Protection of all three Austrian transboundary rivers, the Danube, the Rhine as well as the Elbe are in place [100]. Still, detailed assessment and projections suggest that hydro-political issues will likely increase in all three river basins and particularly the Danube [29].

3.7. Indicators for Target 6.6

3.7.1. Critical Appraisal of Indicators for Target 6.6

A mere quantitative assessment of the extent of water-related ecosystems as conducted within Indicator 6.6.1 is widely agreed not to be sufficient to describe Target 6.6. It neither allows to capture the status, quality or health of the ecosystems, nor the degree of protection [14,16,28,151,152]. Artificial and restored systems are included as well. While not to be underestimated [153], their ecological systems, functions and ecosystem services can differ significantly from natural ones. The list of types of water-related ecosystems mentioned in the target is extensive, but some are neither covered by Indicator 6.6.1, nor by another SDG indicator. Especially types strongly linked to water services (e.g., cloud, riparian, peat and dryland forests) are required to be included [16,152]. Water quality is partly covered by Indicator 6.3.2, but the number of variables for the core indicator is small and hydro-morphological aspects are not covered. Complementary indicators should be employed to gain insight into sediment budget and transverse structures and to enable a basin perspective to describe continuity and interdependencies, which are essential for provision of ecosystem services [20]. Further, assessment of interlinkages with other SDGs (e.g., agriculture, biodiversity) needs to be enhanced [8].

By monitoring the change of extent, results will be highly influenced by the chosen baseline reference (a survey around 2017), which arguably could be more adequate by using a natural or historical reference as baseline [16]. Capacity challenges for monitoring and reporting are present in many countries, particularly to cover temporal and spatial dynamics. The use of earth observation to monitor, validate and assess accuracy is promoted and its improvement is topic of on-going research [32,154].

3.7.2. Status Quo of Target 6.6 in Austria

An extensive information basis on problem areas of Austrian water streams (catchment area > 10 km^2), lakes and groundwater aquifers is available in the national water management plan of Austria [93] (Table 9). The majority of water streams (~57%) is designated at risk due to hydro-morphological pressures rather than pollution (~14%). Sediment transport and fish passage are also mentioned as major critical aspects. In response, a broad set of measures is formulated and awaits implementation [93]. Wetlands and swamps considered worth protecting are covered by the European Habitats Directive [155]. Still, some very small water streams (catchment area > 10 km^2), springs, wetlands and swamps are not covered by existing regulations and consequently no comprehensive status assessment is available [100].

Table 9. Possible complementary indicators for Target 6.6 and available data for Austria. "n.d." indicates that no data for Austria were available, suggesting a potential data gap. "*" denotes complementary data that do not explicitly correspond to a complementary indicator suggested in the screened literature but could be directly linked to one of the critiques expressed and complemented the given information.

6.6.1	**Change in the Extent of Water-Related Ecosystems over Time**	**10% of the Water Basins in Austria Is Experiencing Rapid Changes in the Area Covered by Surface Waters [37]**
Category	**Complementary Indicators**	**Available Data for Austria**
Metric	Water extent [68]	636 km^2 (2019) [68]

Table 9. *Cont.*

6.6.1	**Change in the Extent of Water-Related Ecosystems over Time**	**10% of the Water Basins in Austria Is Experiencing Rapid Changes in the Area Covered by Surface Waters [37]**
Category	**Complementary Indicators**	**Available Data for Austria**
Water quality	Ecological water quality/ecological water status [15]	see Target 6.3 (Table 6)
	Pesticides in the water environment [8]	see Target 6.3 (Table 6)
	Trace toxic substances [8]	Based on 63 synthetic substances, yearly environmental quality standards were in none of the assessed river-sites exceeded [94]
	Number of monitoring sites in rivers with respective status class for ammonium (NH_4-N) [8]	Very good/good: 90 (100%)
	Spatial extent and quality (Total suspended solids and chlorophyll-a) using earth observation complementary and in combination with to ground-based monitoring [154]	n.d.
Various types of ecosystems	Land cover change *	Percent of change from/to sparse vegetation, cropland, bare area, shrubland, wetland, artificial surfaces, tree cover, inland water, grassland [156]
	Global Forest Watch Water data [152]	Details on tree cover change available [157]
Protection	Extent of forests managed for soil and/or water protection [152]	3,869,000 ha (2015) (261,000 ha thereof for production of clean water) [158]
	Protected areas [16]	29.2% of total land [159]
	Natura 2000 protected areas [16]	12,895 km^2 or 15.4% of terrestrial area [160]
	National expenditure on environmental protection by institutional sector *	12,461.4 Million € [161]
Connectivity	Wetland dysconnectivity *	Danube: Low; Rhine: Very low; Elbe: Moderate [144]
	Ecosystem impacts from dams *	Danube and Rhine: Very high; Elbe; No data [144]
	Hydro-morphological pressures *	For 63% of all water bodies that fail to reach the target of good ecological status fail this due to hydro-morphological pressures [93]
Biodiversity	Threat to fish *	Danube and Rhine: High; Elbe; No data [144]
	Extinction risk *	Danube: Very high; Rhine: Moderate; Elbe; Low [144]
	Threatened species (in percent of known species) *	Mammals: 27%, birds: 31%, reptiles: 64%, fish: 46%, vascular plants: 33%, mosses: 27%, lichens: 21%, invertebrates: 2% [159]

According to the national water management plan of 2017 [93], the objective for 2027, to reach good ecological status, is currently achieved by 37% of the assessed water streams and close to 50% of the lakes (<50 ha). Less than 15% of the water streams are in a very good ecological status and only 1% are accompanied by intact riparian areas. Similarly, many fish species are endangered [162] and for other biological quality indicators, e.g., macrozoobenthic, insufficient data are available. Many of the formerly existing riparian areas were lost in the 19th and the beginning of the 20th century. The status of the existing ones is captured in the Austrian inventory of riparian areas, 60% of which are under protection by now [163]. Further, 23 regions are protected under the Ramsar Convention on Wetlands [164,165]. Yet, several habitat types are threatened with extinction [166].

3.8. Indicators for Target 6.a

3.8.1. Critical Appraisal of Indicators for Target 6.a

Despite specification of a broad range of SDG 6-related activities in Target 6.a, the core indicator only covers water and sanitation related activities and disregards other components such as hygiene, recycling and reuse [16,17,20]. Indicator 6.a.1 further does not cover the quality of assistance, a significant factor, considering that there is no substantive evidence for a general link between volume of official development assistance (ODA) finance and WASH progress [17]. Moreover, the indicator is criticised for implying that international cooperation primarily corresponds to ODA, excluding non-official activities (e.g., non-governmental organisations (NGOs) or private entities) [16,17,20] and not distinguishing between grants and loans [17]. International cooperation is further oversimplified by defining countries as either donors or recipients and referring to *developing countries* as only those recognized in the OECD Development Assistance Committee list [16]. Co-operation is restricted to aid, leaving out other types of cooperation such as knowledge and free sharing and exchange of data [16,20]. The indicator is found to lay emphasis on infrastructure spending and capital investments rather than long-term solutions and soft interventions such as capacity building [16,17,20].

As apparent in Table 10, few complementary indicators are suggested. Country programmable aid constitutes a subfraction of ODA, is subject to multi-year planning and can be used as proxy for the amount of ODA "*over which recipient countries have, or could have a significant say*" [167]. The indicator on grants by private agencies and NGOs could be used to cover part of non-public aid.

Table 10. Possible complementary indicators for Target 6.a and available data for Austria. "*" denotes complementary data that do not explicitly correspond to a complementary indicator suggested in the screened literature but could be directly linked to one of the critiques expressed and complemented the given information (ADA = Austrian Development Agency).

6.a.1	**Amount of Water- and Sanitation-Related Official Development Assistance That Is Part of a Government-Coordinated Spending Plan**	**n/a** [37]
Category	**Complementary Indicators**	**Available Data for Austria**
Quality	Country programmable aid (only cumulated data available, no data on WASH sector available) *	81.7 million USD or 13% of bilateral ODA (2014) [168]
	Total ODA *	1630 million € (2019) ~ 0.4% of gross national income (GNI) [169]
	Austrian Development Cooperation by ADA (ODA-relevant) *	101.74 million € (2019) ~ 6.2% of total ODA [170]
	Water-relevant *	6.73 million € (2019) ~ 7% of ODA by ADA [171]
Narrow definition	Grants by private agencies and NGOs (only cumulated data available, no data on WASH sector available) *	163.09 million USD [172]

3.8.2. Status Quo of Target 6.a in Austria

At international average, around 5% of ODA are spent on WASH-relevant development cooperation [77]. Between 2005 and 2019, the total bilateral means of the Austrian Development Agency (ADA) for Austrian Development Cooperation (ADC) amounted to approx. 65 to 100 million Euros per year [171], of which between 7% and 14% were spent in the water sector. Total ODA increased over the past ten years [169] but is still far from the internationally targeted 0.7% of gross national income (GNI) [173].

To monitor impact of international cooperation, alignment along the SDG 6 targets could be expanded to capture relevant non-ADA-means and should be subjected to clear, scientific criteria. Despite impact studies being laborious for a whole sector [174], they are doable on project or programme level [175]. One of the two focus areas of the current ADA strategy for sub-Saharan Africa is IWRM, a topic where Austria could contribute its know-how gained within the international commission for the river territories of Danube, Rhine and Elbe and the WFD [92,93].

3.9. Indicators for Target 6.b

3.9.1. Critical Appraisal of Indicators for Target 6.b

The core indicator of Target 6.b does not allow to measure the actual implementation or impacts of the addressed participation and is found to require improvement to better reflect if rights to information, voice and remedy are effectively accessed [17]. The indicator only specifies on local administrative units, but participation can also occur at all government levels or outside governmental structures.

Few complementary indicators and corresponding data are available (Table 11), highlighting a gap in methodological approaches at hand to assess Target 6.b.

3.9.2. Status Quo of Target 6.b in Austria

Decision-making in the water and sanitation sector in Austria is highly formalized. All relevant stakeholders (e.g., those affected in a water rights procedure) are contacted by the authority in the course of the procedure. Participation is also stipulated within the European Water Framework Directive [92]. While technically participation is foreseen, this happens often rather as formality [100].

The lack of complementary indicators hampers comprehensive and reliable assessment of the status quo of Target 6.b in Austria.

3.10. General Critical Aspects Related to the Use of Indicators

Indicators are found to be a strong instrument for communication and facilitation of discussions with and between stakeholders [78]. Yet, limitations of solely quantitative approaches exist and need to be acknowledged. The "*language of numbers*" enables capturing tangible goals, but fails to reflect on processes, local particularities and structural elements that support or hamper transformation [4] (p. 14). Rather than merely using the indicator framework, a comprehensive qualitative analysis with a focus on the goals is recommended as basis for monitoring SDG implementation [4] (p. 5). This was incorporated within this paper by critically appraising the indicators from a target perspective, amending them with a diverse set of complementary indicators and in combination formulating a broad, descriptive baseline for decision-making and integrated implementation of all SDG 6 targets in Austria. Taking Target 6.6 as example, the corresponding core indicator on the change in the extent of water-related ecosystems might inform about the current quantitative development of ecosystems. Yet, it does neither suffice to capture the quality and health of the ecosystems and processes influencing them nor give information about local problem areas and protective measures. Similarly, implementation of Target 6.3 can profit from complementary information, e.g., on the types and sources of pollution or deduced challenges concerning water quality. For Austria, several complementary indicators are proposed and discussed to inform about local particularities (e.g., specific legal requirements or groundwater being the sole drinking water source) and detect problem areas such as the hydro-morphological status and diffuse pollution. Particularly, the national water management plan provides a comprehensive assessment for a number of types of water-related ecosystems to complement monitoring of these targets.

Table 11. Possible complementary indicators for Target 6.b and available data for Austria. "n.d." indicates that no data for Austria were available, suggesting a potential data gap.

6.b.1	**Proportion of Local Administrative Units with Established and Operational Policies and Procedures for Participation of Local Communities in Water and Sanitation Management**	**Target Largely Achieved [68]**
Category	**Complementary Indicators**	**Available Data for Austria**
Quality of participation	Procedures in law or policy for participation by users/communities (target: 10 = clearly defined) [41]	10 [41]
	Level of participation by users/communities in Austria by sub-sector (drinking water urban/rural, sanitation urban/rural, water resources planning and management) (target: 3 = high) [41]	3 [41]
Formal/informal; gender	Female/male membership with position and responsibility in local or community, formal and informal institutions, for managing irrigation or water supply [33,42] [1]	n.d.
	Participation by female/male members (with position) in decision-making meetings in local or community, formal and informal institutions, for managing irrigation and water supply; reasons for participation/non-participation; proportion of female/male participation; number of gender-specific decisions adopted resulting from contributions made by female/male members [33,42] [1]	n.d.

[1] Exemplary selection from a comprehensive set of more than a hundred indicators on water and gender issues provided within the UNESCO WWAP Toolkit [33].

Future research could aim at furthering monitoring approaches for disaggregation and localisation, the MoIs but also specific, often normative, aspects currently given too little consideration such as resilience, equity and justice. The need for disaggregation can be underlined using the example of water availability (Target 6.4) in Austria, which shows an overall satisfactory performance but requires temporal and spatial disaggregation to identify problem areas and support corresponding decision-making at local level [98]. To coherently monitor SDG 6 targets, evaluation of manifold interlinkages, synergies, as well as trade-offs with other targets should be intensified. Fostering synergies (e.g., the improvement of water quality leading to increased freshwater supply) and avoiding trade-offs (e.g., the expansion and intensification of agricultural areas and potential corresponding deterioration of water quality) might also lead to more effective and efficient use of MoI [8,16]. Composite indices might be one way to go, but potentially hide disaggregated information and require subjective weighting, a task for the policy-science arena [78]. The Transboundary Waters Assessment Programme [144] provides an interactive tool to define weights for a broad set of indicators on transboundary rivers and individually create indices.

Others advise intensifying the research on measuring the unmeasurable by "*measuring what we treasure*" rather than vice versa and suggest investing in novel measurement approaches and sources for data generation, particularly in the context of justice and equity, such as big data, estimates by algorithms, geo-referenced data and crowd-sourcing [4] (p. 13). Several references also recommend these approaches to close the various gaps in monitoring the SDG 6 targets [114,176–180], that are also identified within this paper. One attempt to close the data gap concerning MoI is the SDG 6 Policy Support System (SDG-PSS), which has been designed to support national governments and stakeholders to collect and amalgamate data on the SDG 6 components status, capacity, finance, policy and implementation, gender, disaster risk reduction/resilience and integrity [181]. Another one, the UNESCO WWAP Toolkit on Sex-disaggregated Water Data, addresses the gap of gender-responsive data. It provides a comprehensive set of more than a hundred indicators on water and gender issues, of which a selected set of exemplary indicators is included in this paper [33,42].

Another step towards sound monitoring of the degree of achievement would be to set numerical national targets. Some of the target wordings imply a numerical value, *access for all* can, e.g., be interpreted as 100%, others are formulated vaguely, and target setting would require elaborated stakeholder involvement. While the criterion of being *achievable* as defined within this paper (Table 2) ensures that target setting would be theoretically feasible, thoroughly doing this for the presented set of indicators (e.g., according to the procedure presented by Dickens et al. [24]) is out of the scope of this paper. Still, for many of the suggested indicators, such as those provided by EUROSTAT [38], the OECD [37] and the JMP [39], benchmarking could be carried out and for those suggested by Essex et al. [15] EU-centric targets are provided.

With regard to the "*race for indicators*" (p. 1), it is argued that the goal should not necessarily be to develop new global indicators but rather to assist in drafting guidelines for the development of indicators that have the potential to close the gaps between reporting and monitoring for effective policy and decision making [16]. The assessment shows that, particularly in a country like Austria where basic water and sanitation and corresponding monitoring and management are widely in place, digging deeper and using complementary indicators is valuable and practicable to fully grasp the potential need for action.

As discussed within this paper and formulated by Vanham et al. [28] (p. 231), indicators can be only "*one part of the bigger picture*", but, if applied comprehensively and coherently, they can support decision making at national level and beyond. The initial set of indicators will be reviewed and complemented to monitor regional and national levels once more in 2025 [182]. While this paper does not claim that the set presented here is fully comprehensive and practicable at global level, it aims to contribute to on-going discussions and understanding for the need of complementary indicators at national level to shed light on various aspects of SDG 6 currently neglected.

Despite focussing on the Global North in this study, we are fully aware of the tremendous deficits worldwide in achieving SDG 6 and want to remind of the Agenda's aspiration to reduce inequalities between countries [1]. By no means shall this goal be diminished but it should be supported by critically reflecting on challenges in sustainable development and by highlighting respective problem areas in a national context.

4. Conclusions

Based on the results of the discussion on the indicators of the SDG 6 targets, the following general conclusions can be drawn:

- The set of core indicators proposed by the UN does not fully cover the aims of the specific targets and various aspects that would be necessary to thoroughly capture whether a country's development is entirely sustainable, e.g., the aim to increase recycling and reuse is not covered by the indicators for Target 6.3. Details on other aspects that are insufficiently covered can be found in the sections on the critical appraisal of the indicators for the respective targets.
- A multitude of complementary and SMART indicators is available for Targets 6.1–6.6, that can be particularly relevant for countries of the Global North and in consideration of the Agenda 2030's aspiration of developed countries leading action. For Targets 6.a and 6.b, complementary indicators are rare and further research would be needed to draw a comprehensive picture of the status quo of these targets.
- Complementary indicators increase the knowledge on specific aims of the targets but also the efforts required for reporting on the progress of achievement of SDG targets. Considering the complexity of coherent monitoring and persistent and prevalent data gaps for the core indicators, the need to keep the global indicators framework simple is evident.
- Although the indicators are designed to allow country-wide assessment and country-to-country comparison, one should not forget that to achieve the targets more specific information is required. Disaggregation of data, e.g., according to gender, age, location is highly needed and recommended wherever relevant in consideration of the potentially increased monitoring efforts.
- While quantitative indicators might be helpful for benchmarking and trend analysis, for policy making they need to be discussed within a broader national context. To fully assess target implementation and allow priority setting, defining of targets and weighting based on stakeholder discussions might be necessary in a follow-up step.
- Interlinkages within the SDG 6 targets and with other SDGs are apparent. Indicators could be used as a means to underline these interlinkages, e.g., using composite indices and enable clear communication and effective implementation. This was not the focus of this assessment and could be enhanced in future studies.
- Future research could aim at developing methods for efficient disaggregation, localisation and the closing of data gaps of core as well as complementary indicators. Further, the development of complementary indicators for the MoI and several aspects of sustainability, that are currently not sufficiently covered and partly difficult to measure, deserve intensified research.

Specific conclusions can be drawn based on the assessment of the SDG 6 indicators for Austria as an example for a country in the Global North with widely established water and sanitation infrastructure:

- Complementary indicators, for many of which data are readily available, can ensure more specific and complete assessment towards reaching SDG 6 targets in Austria and be used to complement progress reporting, e.g., within the Voluntary National Reviews.
- Targets 6.1 and 6.2 are achieved to a great extent in Austria, yet, continued efforts are required to provide and guarantee safely managed systems. In-depth assessment to cover WASH access in public spaces as well as for vulnerable and marginalized groups could be useful. Infrastructure investment should correspond to the respective needs

and be managed with foresight considering future challenges like climate change, population changes and resources depletion.

- Comprehensive data on water quality in Austria to complement Target 6.3 are widely available. However, diffuse pollution from mainly agriculture is one of the major challenges. In-depth assessment of interlinkages could be one way to tackle this. Recovery and reuse of energy, water and nutrients are not extensively practised but are currently becoming more relevant.
- Integrated monitoring of Target 6.4 is complex and requires a set of indicators and corresponding interlinkages to be assessed. Assessment at the level of groundwater bodies indicates an at least good status for all groundwater bodies at present but two exhibit risk to fail this status in 2027. For a comprehensive picture of local challenges, a more detailed spatially and temporally disaggregated assessment would be required. Besides domestic water resources, water resources abroad should be protected by tackling the high external water footprint of Austrian consumption.
- While Target 6.5 is doubtlessly difficult to grasp, IWRM level in Austria appears to be relatively high and, with the national water management plan and transboundary arrangements for water cooperation for all relevant rivers, a solid basis for the future is existing. Adequate financing, integrated land use management, participation and fragmented responsibilities are identified to be the bottlenecks for more comprehensive implementation. Tackling these is imperative considering the importance given to widely established IWRM to meet future challenges.
- As main deficits for achieving Target 6.6, hydro-morphological pressures and diffuse pollution are identified. These impact, among others, sediment balance and biodiversity, and threaten various species and ecosystems.
- Insufficient data are available on the impact of water-related development cooperation of Austria. Taking the internationally agreed target of 0.7% of GNI as benchmark, financial development aid is not sufficient to achieve Target 6.a.
- Data basis for Target 6.b is sparse and few complementary indicators are suggested. Decision making in the water sector in Austria is strongly formalized and while technically participation is foreseen, it is often rather a formality. Nonetheless, participation, or more generally speaking, transdisciplinary processes, will be key to achieving the sustainable transformation aspired within the Agenda 2030.
- While Austria and the identified complementary indicators can serve as example for a country in the Global North, the results are particularly relevant for the Austrian context. A similar assessment for other countries might result in a different set of suitable indicators.

Based on the here developed broader picture of the SDG 6 targets and the identified problem areas, options for action for the achievement of the Agenda 2030 in Austria should be developed. The here presented approach is limited to predominantly quantitative indicators and mainly based on the scientific discourse. Future discussions in the policy-science arena are recommended to develop concrete measures for the implementation of SDG 6, national numerical target values and composite indices for easy communication.

Author Contributions: Conceptualization, V.G. and G.L.; visualization, V.G.; writing—original draft preparation, V.G.; writing—review and editing, G.L.; supervision, G.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research is part of the UniNEtZ project (https://www.uninetz.at/en/) (accessed on 31 December 2021) that is funded by the Austrian Ministry of Education, Science and Research. Further funding was received by the University of Natural Resources and Life Sciences, Vienna (BOKU) (PhD Position and Contribution to APC) and the Doctoral School Transitions to Sustainability (T2S) (Contribution to APC).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: We thank the UniNEtZ SDG 6 Working Group for the helpful discussions on the SDG 6 targets, indicators and the status quo in Austria and Lorenz Schober for the work in his master's thesis as starting point of this research. Funding of the UniNEtZ project by the Austrian Ministry of Education, Science and Research is greatly acknowledged. Additionally, the work of Verena Germann is supported by the BOKU doctoral school "Transitions to Sustainability (T2S)". We also thank the Rectorate of BOKU for the support.

Conflicts of Interest: The authors declare no conflict of interest.

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