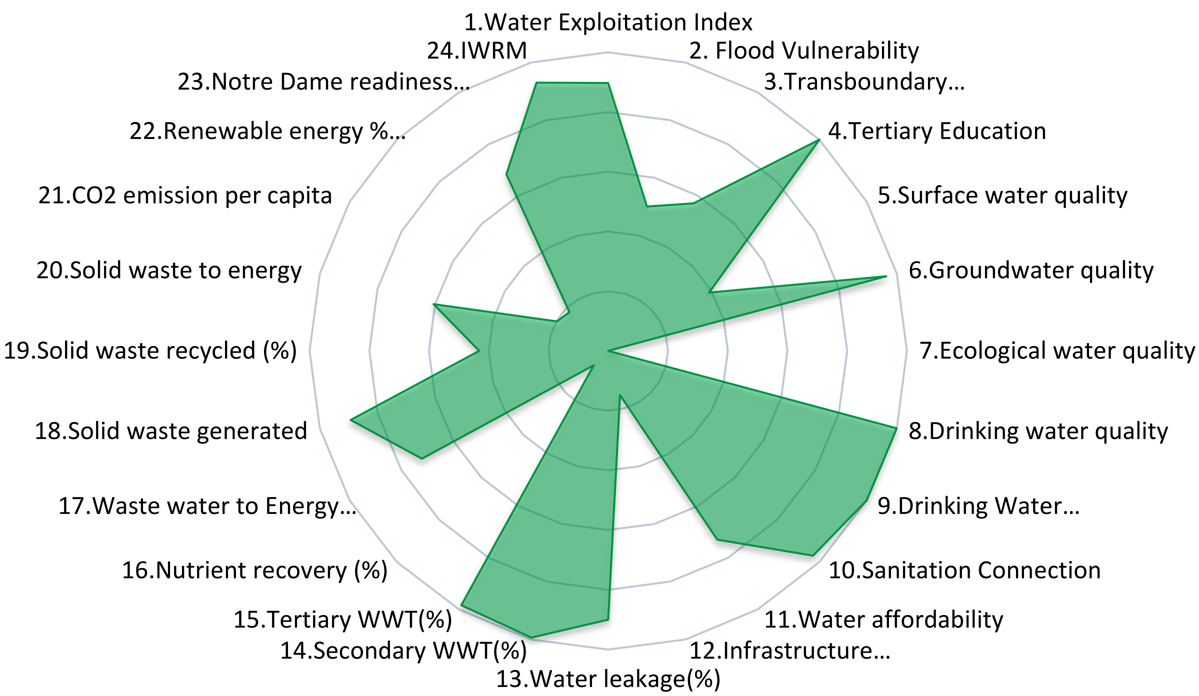
The National Blueprint Framework

A proposal for a set of water-related indicators to monitor progress on SDGs



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The National Blueprint Framework - A proposal for a set of water-related indicators to monitor progress on SDGs

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Executive Summary

With the end of the Millennium Development Goals (MDGs) in 2015, the Sustainable Development Goals (SDGs) were created to continue the international agreements for sustainable development. Building on the eight goals in the MDGs, the SDGs include 17 goals, including a specific goal for water, SDG 6. The goals are designed for all countries, compared to the MDGs which focussed on the global south. This leads to the goals, their targets and associated indicators being designed for a global audience, with each country having different baselines and feasible final situations in 2030. The study was commissioned by AIWW 2019 and Waternet to show the current progress and challenges in water related SDGs at a national level in Europe. To achieve this the following research question was addressed:

What indicators can be used to create a water management framework to be used globally, which complements indicators used for the SDGs?

This study provides a new perspective on monitoring the SDGs. To assess the current environment of water management indicators, a database has been developed of integrated water resources management (IWRM) indicators which were then correlated against the SDG targets and indicators to identify which could be used for monitoring the progress towards achieving the SDGs. From here a proposal for a National Blueprint Framework (NBF) was created comprising of 24 water-related indicators, centred around SDG 6, each with an associated target.

The SDG indicators are a useful framework for monitoring progress towards water-related targets, but there are clear limitations. Firstly, some of the SDG indicators are not SMART (Specific, Measurable, Achievable, Relevant, Time-bound). Secondly, important aspects of the European policy agenda (e.g. water in the circular economy) are currently not included. Thirdly, in some areas clear policy targets are lacking, whereas quantitative policy targets would really aid to the communication of progress of the SDGs in general. In the NBF proposal these aspects have now all been addressed. Instead of measuring the current state, or the trend over time, the NBF indicators can be used to measure the progression towards achieving the target (distance-to-target) for each indicator by 2030. In this way, the results will show how far countries have come, and which areas require the most focus. This is essential because "what is measured, will get managed and can be communicated". The proposed indicators and targets of the NBF will need further international discussion at the science-policy interface to obtain broad international acceptance.

The scores of the indicators showed a low standard deviation for the EU28, ranging from less than one to four. However, they also showed low levels of correlation between the indicators suggesting that the NBF framework had no internal dependencies. Whilst the national level scores correlated with city-level water management scores within the EU28, suggesting that it is applicable for monitoring in Europe, the framework was less successful for non-EU countries due to lack of data availability and EU-centric targets for each indicator. This needs further research and political attention as the most important direct water-related challenges are not within Europe but outside Europe.

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List of abbreviations

BCI	Blue City Index
SDGs	Sustainable Development Goals
MDGs	Millennium Development Goals
UN	United Nations
CBF	City Blueprint Framework
NBF	National Blueprint Framework
WHO	World Health Organisation
IWRM	Integrated Water Resource Management
WPI	World Poverty Index
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
OECD	The Organisation for Economic Co-operation and Development
EU	European Union
TWAP	Transboundary Water Assessment Programme
ADB	Asian Development Bank
WWT	Wastewater treatment
NBI	National Blueprint Index
IBNET	The International Benchmarking Network for Water and Sanitation Utilities

1. INTRODUCTION

1.1 Water challenges and sustainable development

Water is crucial for human survival, the minimum amount required to live is given as 50 litres per person, each day (Hunter et al., 2010). This however, does not include the amount of water used in agriculture, industry and which is required to maintain the earth's ecosystems. The global population is increasing and is predicted to reach 8.5 billion by 2050, with over half of the population concentrated in less economically developed nations (United Nations, 2015a). As these nations develop, the standard of living will increase and so with it the consumption of more water. At present, the average person in the Netherlands consumes 128 litres of water each day, compared with an individual in Arizona consuming 1800 litres (Water Research Foundation, 2016) but only 10 litres daily consumption in a rural Tanzanian village (Moel et al. 2016). An individual's lifestyle and opportunities, combined with the availability of water influences how much is used. Rural to urban migration and population growth result in an estimated increase in urban population – from 4.2 billion in 2018, to 6.7 billion in 2050 (United Nations, 2018). With the location of many of these urban areas close to large river or in coastal environments, there will be an increased population vulnerable to sea level rise, land subsidence and flooding (Koop & van Leeuwen, 2015b).

Public water use is not the major freshwater use. In Europe, 44% of extracted water is used for agriculture and 40% for industry and energy production (EEA, 2018). Water footprint analysis shows that actual water use for agriculture may exceed 90% (Hoekstra et al., 2012). Indirect water use via food consumption is enormous and exceeds 3000 litres daily for most European Union (EU) citizens (Gawlik et al., 2017). With the increase in global population, the demand for food is expected to increase, added to this, the global trend towards a more meat-based diet will result in higher energy and food requirements per joule of energy contained in the food. To meet the increased food demand, land use is currently changing, with the loss of natural grassland and forests to meet the need for agricultural land (Lambin & Meyfroidt, 2011). The intensification of agricultural practices may increase with the use of agrochemicals to provide higher food yields. Loss of natural land reduces the area of natural water filtration and increases surface run off, increasing flood risk particularly in densely populated deltas and along the rivers and coasts. Use of chemicals in agriculture is a key contributor to water pollution (OECD, 2018), the extensive amount of irrigation, and monocultures also lead to land degradation.

Whilst agriculture has direct environmental impacts on water quality, it also has indirect effects due to the increase in energy requirements. Both groundwater pumping for irrigation and increased agrochemical use result in increased energy use per hectare (Rasul, 2016) as well as industrial waste.

Water is an important resource, with increasing demand but is also a critical requirement to the development of multiple sectors discussed above. With the end of the Millennium Development Goals (MDGs) in 2015 (United Nations, 2015b), the Sustainable Development Goals (SDGs) were developed to continue the international agreement to sustainable development, this is known as the 2030 Agenda for Sustainable Development (United Nations, 2015c). As water is so relevant, it was included as an individual Sustainable Development Goal (SDG) for Agenda 2030.

Implemented in 2015, the SDGs, seen in Figure 1, form an internationally recognised set of goals and targets which aim to promote development in the economy, environment and society. There is a total of 17 goals containing 169 targets with a focus on *people, planet, prosperity, peace and partnerships*.

Figure 1 *The water-centric 17 Sustainable Development Goals for each sector (United Nations, 2015c; Makarigakis & Jimenez-Cisneros, 2019).*

Each goal has individual targets associated with it, SDG 6 aims to address the increasing global problem of water scarcity with the aim to: *Ensure availability and sustainable management of water and sanitation for all* (United Nations, 2015c). To enable this to happen six targets have been agreed with nine associated indicators, see table 1.

Table 1. *The six targets and associated indicators for SDG 6 of the SDGs (United Nations, 2015c).*

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 safely managed sanitation services, including 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 wastewater 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 implementation (0-100) 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

Target 6.5 of SDG 6 is to implement Integrated Water Resources Management (IWRM) at all levels. IWRM is a policy making philosophy that aims to have a comprehensive and holistic approach to water management. It was first discussed at the United Nations (UN) conference on environment and development in Rio de Janeiro in 1992. It became popular in part due to its broad scope, with a focus on water resources, water users as well as spatial and temporal scales. Overarching these different sections of water management are the policy principles of Equity, Ecological integrity and Efficiency (Savenije & Van der Zaag, 2008). However, what made IWRM popular was also part of its downfall; the broad scope, ambiguity of the concept and the lack of data made it difficult to create a holistic IWRM assessment framework for a national scale (Medema et al., 2008).

In order to assess the effectiveness of the IWRM and to provide feedback for decision makers, indicator frameworks are used. Many indicator frameworks focus on an individual problem such as the Water Stress

Index and the Water Poverty Index (WPI). Both Indices focus on water availability and do not include a holistic overview including the management of waste or governance capacity. There are also problem regarding the complexity of WPI as many decision makers view it as too complicated (Petit, 2016)**.**

To decrease the complexity of IWRM indicators, some have chosen to focus on a specific geographic area such as the INBO Performance Indicators for African Basin Organizations or CAP-Net, a United Nations Development Programme (UNDP) indicator for basin scale management.

Indicators on a city level include the City Blueprint Framework (CBF) which uses multiple performance orientated indices which report on different aspects of IWRM. The geometric average for each of the 25 indicators of the CBF forms the Blue City Index (BCI), that is available for more than 70 municipalities and regions in 40 different countries (Koop, 2019). However, there is a lack of national level indexes that aim to give a holistic report on water management strategies.

In recent years IWRM has begun to lose its influence as an attractive management framework. There have been suggestions within the literature to move away from a one-size -fits-all framework (Giordano & Shah, 2014). This can be seen in the UNs World Water Development Reports which, in 2012 placed IWRM as a central focus of the report, in 2015 it was scarcely present (Petit, 2016).

Since the initial discussion of the IWRM idea, other decision-making philosophies have also been suggested. Building on the holistic approach of IWRM, the nexus concept aims to integrate more than one area of resource management with an aim to optimize synergies and trade-offs (Kurian, 2017). Initially suggested at the World Economic forum in 2011, the energy-food-water nexus aims to limit the effect of the silo approach to resource management – where the individual management of one resource has negative impacts on others (Kaddoura & El Khatib, 2017). As not every individual can be all knowledgeable, the nexus approach requires cross departmental integration, which can often be challenging to achieve.

A similarity in the two approaches is that IWRM and the food-water-energy nexus use indicators to monitor their effectiveness and so often experience the same problems; the difficulties in selecting relevant indicators, data availability, a clear focus and useable communicable results (Kurian, 2017; Petit, 2016).

Both the IWRM approach and the nexus approach have overlapping features; Both aim to have a holistic strategy for water management taking into account the use of water as a resource for human consumption, the environment, and the economy. In this way, having two separate approaches within the literature can be misleading as both management strategies value similar governance pathways.

The following study has been commissioned by AIWW 2019 and Waternet to show the current progress and challenges in water related SDGs at a national level in Europe. The identified challenges can provide direction to the focus and themes of AIWW in 2019 – 2030. The approach described in this report has been presented and discussed in 2 round tables at the AIWW Summit 2018 (15 November, Rotterdam). Results from the review by the AIWW Advisory Committee will be incorporated in the final report, and the results of the study will be presented at AIWW 2019. Although this study is about the indicative monitoring of water related SDGs at a national level in Europe, the aim is to expand the index to be used at a regional and organisational level in the future.

1.2 KNOWLEDGE GAP

Whilst the 17 individual SDGs are beneficial in that they together emphasize the extent to which sustainable development is interdisciplinary, they also result in individualising the different components of sustainable development. The further division of each goal into separate targets results in national managements strategies aiming for distinct targets within the goals rather than a cohesive development strategy. The problem of individualising the goals is that many have conflicting interests which result in synergies and trade-offs between the ability to meet all the SDGs (Pradhan et al., 2017) The problem of this approach, which fails to highlight conflicting interests, is exemplified in water management. Although, water resources have their own target, SDG 6 focusses primarily on drinking water and sanitation, without appreciating the links between water, energy, agriculture and health. As discussed above, water is crucial to development and its integral role to natural, social and economic life on earth makes it a critical resource necessary to achieving Agenda 2030 (HLPW, 2018). However, due to the diversity of environments and challenges that nations face, there is no single approach for the creation of an IWRM framework to meet the goals (Petit, 2016). Instead nations must create their own policy plans to reach an IWRM approach.

For many nations, this requires governance mechanisms to be strengthened (HLPW, 2018) so that decisive actions can be taken. Although there are theoretical approaches to managing water, often these are very challenging to achieve in practice (Savenije & Van der Zaag, 2008). The governance actions required to meet the SDGs have been left to the individual nations. However, this may lead to cherry-picking of the easiest goals to achieve. This uncoordinated approach may lead to international disputes and unanticipated side-effects.

Although there are currently many city-level indicators for sustainable living and water management (Hoekstra et al., 2018; European Comission, 2015; Koop & van Leeuwen, 2015a; Siemens AG, 2012) alignment is required between national targets and the national and local performance, and national indicators being representative of the whole country. For achieving the SDGs it has been suggested that each country designed their own national strategy. This leads to many countries lacking consistent reporting strategies or the incentive to share data (Malik et al., 2015). Thus, nations and international agencies remain uncertain about their comparative progress towards the SDGs.

Many water-related indicators, whilst useful, do not show the scope of variables affecting water management. For example, the water scarcity index shows overuse of water, however even if a country has water available, it may not be useable due to its poor quality – this is not shown with the water scarcity indicator. Conversely, with a more general indicator, there is a risk that the source of the development problem is lost (World Bank, 2018). Therefore, there is a requirement for a water management index which shows clear indicator results without over-simplifying the information on a national level.

There is therefore, a need for a coordinated approach to water-management that incorporates indicators of multiple sectors for holistic SDG monitoring.

1.3 Research Questions

Based on the observed discrepancy between concepts such as nexus approach and IWRM that consider water as the principle unit of integration on the one hand, and SDGs and their specific targets on the other hand, the following main research question is formulated:

What indicators can be used to create a water management framework to be used globally, which complements indicators used for the SDGs?

1. **What National Indicators currently exist for Water Management Assessment on a national level?**
2. **To what extent do these indicators align with the current Sustainable Development Goal Water targets and indicators?**
3. **Can a more suitable set of indicators be developed taking into account constraints of time and data availability?**
4. **To what extent does the proposed index represent regional variety within European countries and non-European countries?**

Four sub questions have been identified:

Sub question 1 aims to identify what indicators are currently used as part of a water management strategy. Sub question 2 determines if these indicators are appropriate for showing progression of water management towards SDG 6. Sub question 3 assess the feasibility of developing new indicators that are relevant for the index. Sub question 4 relates to the finalization of the model, whereby the performance of the indicator for multiple countries will be assessed.

2. CONCEPTUAL FRAMEWORK

2.1 Sustainable development: a historical background

The frequently cited beginning of the current sustainable development [rhetoric] is “Our common future” (Brundtland, 1987). The anthropogenic focus of sustaining the quality of life for future generations was a common past perspective that sustainable development required economic development to also occur(de Vries, 2012; Robinson & Robinson, 2004) the Brundtland report also stressed the necessity of international cooperation for sustainable development.

This led to an increase in awareness of the importance of sustainable development and also an increase in it being researched and discussed. This led to the development of the Millennium Development Goals for 2000 – 2015. The MDGs are focused on the development of the global south and have an anthropogenic focus of development. Whilst the MDGs had some large achievements (United Nations, 2015b) the economic achievements were greater than the environmental (Georgeson & Maslin, 2018). With the end of the MDGs in 2015, the SDGs were developed to continue the international agreement to sustainable development, this is known as the 2030 Agenda for Sustainable Development. Here there is greater awareness of the environment and the perception of sustainability has evolved to include the requirements of environmental sustainability for achieving social and economic sustainability. The approach of the SDGs is *people, planet and prosperity* to include economic growth, environmental sustainability and social inclusion (United Nations, 2015c).

Compared to the MDGs, the SDGs have a greater number of final goals, with 17 Goals compared to eight seen in the MDGs. Each goal has associated targets that need to be reached, with 21 targets for the MDGs and 169 targets for the SDGs. Although the SDGs have a higher number of targets, the number of indicators per target is less, with only 1.4 targets per indicator compared to the 2.67 indicators per targets seen in the MDGs (Georgeson & Maslin, 2018). In some respects, with so many targets, more indicators per target would require a large amount of monitoring, however a key learning point from the MDGs was that what gets measured, gets managed (Barnett, 2015). The design of the indicators and what they measure affects what becomes developed and people aim to achieve higher results from the indicator monitoring (Bhaduri et al., 2016; Georgeson & Maslin, 2018; Reidhead et al., 2016). Therefore, the lack of indicators may mean that the end goal targets are not met and consequently more target specific indicators may be beneficial. What the indicators aim to achieve is also important; the indicators are present to show progress to achieving the targets and thus the final goals, however in some cases the indicators are not sufficient to discern whether the target has been met. Target 6.1 for SDG 6 (water) includes ‘access for all to a water supply’ therefore to be able to measure if this has been achieved, the data should be disaggregated and collected by age, gender and income (Guppy et al., 2019). Many of the targets are non-numerical and therefore even though indicator data is collected the end goal remains vague (Dickens et al., 2019) and the data can only be used as a comparative to other countries. One way to accelerate the process of achieving Agenda 2030 is by implementing a circular economy – An economy in which waste is reused or recycled and pollution is limited so that natural resources are not depleted (Circle Economy &Ecofys, 2016).

SDGs and support for national water policies

Another aspect to consider is whether the collection of this indicator data is beneficial to the nation collecting it. Continuing with the example above, the ‘access for all to a water supply’ can be compared with other countries, however for the individual nation, it does not provide data on the underlying reason behind the amount of access, an example given is that Ghana lacks water access due to lack of supply, whereas Nepal lacks access to water due to the level of contamination (World Bank, 2018). Understanding the background reason provides more information of development progress internationally but, on a national level provides an indication for the required water management. As well as this, a single national indicator may mask the complexity of the situation within the country. Therefore by collecting the data for the national indicator, it may take limited resources away from regional monitoring and may result in a nation producing two sets of reporting data: one for international reporting and one for their own management (Dickens et al., 2019).

SDGs: Trade-offs and synergies

Furthermore, taking the indicators as individual measurements to work towards may have unexpected consequences. If a linear management approaches are taken, and the indicators are addressed individually - progression towards one indicator, target or goal of the SDGs may result in a cancellation effect. This effect results in progression towards one goal limiting progression towards another. Additionally the development towards one indicator could result in a situation where one indicator then depends on the progress of another in order for development to occur (Scherer et al., 2018). These interlinkages occur due to feedback loops between the goals (Allen et al., 2018) and in some cases due to indicators being used for more than one goal (Pradhan et al., 2017).

The feedback loops between the goals lead to synergies (where development in one goal is beneficial to another) and trade-offs (where development in one goal negatively impacts another). The goals that contain the most synergies are the social development goals: Poverty, zero hunger, good health, education and gender equality (SDGs 1,2,3,4,5). However as noted in section one, meeting these goals may lead to increased water usage. If the increased usage is poorly managed and inefficient it may have a trade-off with meeting SDG 6.

Those with the highest number of trade-offs are economic growth and the environment (SDGs 8,9,12,15;Pradhan et al., 2017). These interactions occur due to the current reliance of economic growth on increasing levels of consumption, at the detriment to the environment. Work needs to be done in these areas to allow economic growth to detach from consumption. Without this, meeting the global population's global needs and therefore meeting SDGs 1-3, will have a detrimental effect on the global use of water and land. Additionally, this increased consumption will increase the carbon emissions (Scherer et al., 2018) and cause a lack of achievement of SDG 13, 15 and 6.

These trade-offs must also be taken into consideration when creating policy to achieve the SDGs. The separation of policy makers in different managerial departments often leads to policy becoming linear, with targets and actions for each indicator (Allen et al., 2018; Nilsson et al., 2016). To avoid this an integrated approach is required to ensure that those actions that have synergies with other targets are well managed (Allen et al., 2018). Achieving good integration can often be hindered by the lack of technical capacity of the policy makers' skillsets. For this reason techniques are required to identify the goal synergies before policy is made. Frequent monitoring must also occur to ensure that cancellation does not occur (Nilsson et al., 2016). These strategies need to occur on a national rather than global level as the difference in national environment impacts the degree to which the synergies occur, and the impact that different actions have. For example in Nordic countries, biofuel does not have a negative impact on food production (Nilsson et al., 2016) and therefore could be used as an alternative energy source.

SDG monitoring programmes

The Following section describes some of the current SDG monitoring frameworks and developments carried out by international organisations. Although national level monitoring does occur using indicators, the greatest trend by nations is target mapping and aligning existing strategies with the SDGs(Allen et al., 2018).

Eurostat focuses on indicator trends for measuring the amount of change towards achieving the SDGs. The use of trends requires historic and current data and whilst Eurostat has both long term and short-term trend data, the lack of historic data is still limiting especially for SDG 6, where there is not enough data to have an overall trend score. In addition to this, the use of trends means that the Eurostat monitoring cannot use new indicators for recently measured data. The display of the Eurostat monitoring focuses on the results of the targets for each goal.

The monitoring carried out by the United Nations Environment Programme (UNEP) is for seven areas of environmental interest with each area having a selection of appropriate targets taken from different goals. Whilst this does work to highlight the synergies between goals, none of the seven areas specifically focusses on the management of water resources.

The Organisation for Economic Co-operation and Development (OECD) has a set of SDG monitoring indicators that focus on the progression towards achieving the goals. Where there is no global data available for an SDG indicator, the OECD has identified an alternative indicator, however in total, the indicators chosen by the OECD only evaluate 57% of the SDG targets (OECD, 2017). Some of the missing indicators include those for water quality and transboundary water management amongst others meaning that SDG 6 is lacking coverage in these areas. The indicators are given as progression towards goals, where the target is either that given within an SDG target or it is the performance of the top 10% of OECD countries. Using the second target would mean that those countries in the top 10% would see no reason for further progression, even in situations where improvement could still occur.

This study intends to provide a new perspective on monitoring the SDGs. The focus here is primarily on SDG 6, with indicators linking to other goals to address the synergies between them. Instead of measuring the current state, or the trend over time, the indicators will measure the progression towards achieving the target for each indicator by 2030. In this way, the results will show how far countries have come, and which areas require the most focus.

3. METHODOLOGY

The following section will outline the key methodological steps taken to address the research question. The methods taken to answer each sub question (restated below) will be addressed individually.

1. **What National Indicators currently exist for Water Management Assessment on a national level?**
2. **To what extent do these indicators align with the current Sustainable Development Goal Water targets and indicators?**
3. **Can a more suitable set of indicators be developed taking into account constraints of time and data availability?**
4. **To what extent does the proposed index represent regional variety?**

3.1 Research Outline

The steps taken in the research framework (Figure 2) include both a qualitative approach (in literature reviews) and a quantitative approach (in data transformation and statistical analysis). The four sections will include the literature review that answers sub question 1 and provides the indicator database used for correlation with the SDG indicators to answer sub question 2. The indicator selection and checking mechanisms is discussed in question 3, which will include the statistical analysis undertaken to check for dependencies in the indicators. The final section will discuss the statistical analysis carried out to answer question 4.

3.2 IWRM indicator assessment

The aim of the IWRM indicator assessment is to answer sub question 1, in determining what IWRM indicators are currently used at a national level. To do this a literature review was carried out.

A further in-depth assessment of the individual indicators used for the IWRM index was then carried out. This was done by entering each new indicator into a spreadsheet. The spreadsheet will count the number of times an indicator gets entered   A problem arises where indicators are essentially the same but are described differently. So, indicators with a similar measurement, even if they had a slightly different wording were grouped together for example “water related risk” from the sustainable city index(Batten, 2016) and “exposure to floods and drought” from the TWAP-rivers indicators(Niasse, 2006) would be grouped together.

Research Framework

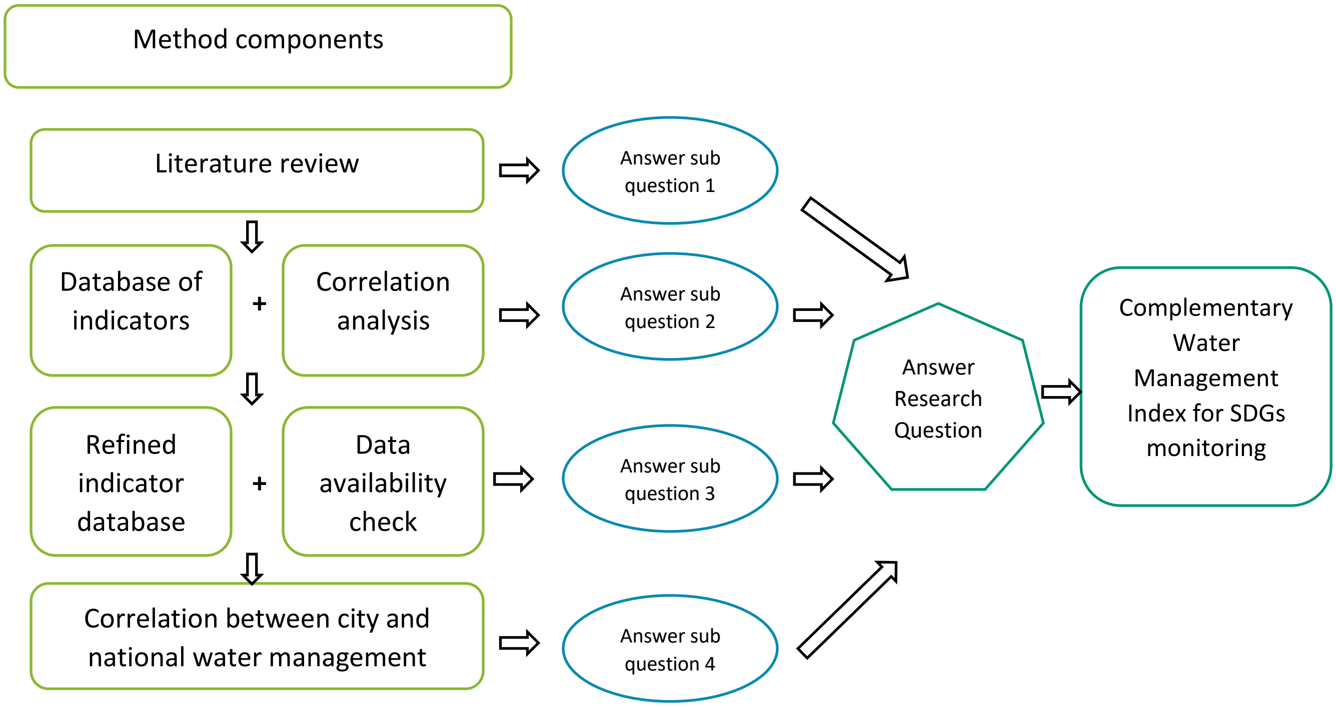

Figure 2 *Methodological steps taken to answer the research question.*

3.3 Indicator alignment with the SDG targets and indicators

The second question sub question asks how well the idicators found in question one align with the SDG targets and indicators. To be able to create a national level indicator to monitor progression towards the SDGs the differences between the needs of SDG monitoing and the current indicators, that is, the gaps in monitoring, must be known and understood.

The process was carried out in two stages. Initially a literature review was carried out to identify weaknesses and areas for improvement in the selected targets and indicators for the SDGs. This was done using Scopus with the search terms "sustainable development goal" AND water AND "goal 6" AND indicators, "SDG" AND water AND "goal 6" AND indicators, "sustainable development goal" AND "goal six" OR "goal 6", "sustainable development goal" AND water AND "goal 6" AND indicators AND review, "agenda 2030" AND water AND indicators for the years between 2015-2019. This yielded a cumulative total of 217 papers, of these those relevant for review were then selected. The time zone was chosen partly to limit the responses but most importantly to select papers that were reviewing the indicators once they had been chosen and begun to be implemented rather than earlier papers that would focus more on theoretical forecasting.

Following this review, a correlation analysis was then carried out between IWRM indicators entered into the database devised to answer question one and SDG target and indicators. The Pearson correlation coefficient (r) was used to assess the relationship between the IWRM indicators and the SDG indicators as well as the IWRM indicators and the SDG targets. Pearson's correlation was used as it is appropriate for use with results of different scales, as both variables are treated equally.

The results of this section were then used to identify which indicators for IWRM, that align with monitoring progression towards the SDG targets, were advantageous to include in the National Blueprint Framework (NBF).

3.4 Identification of more suitable the indicators

Sub questions 1 and 2 identified the range of indicators used now, those needed to monitor SDGs and from that the need for new and more suitable indicators. These results were then used to develop the NBF, following a similar approach to that used for the CBF (Koop & van Leeuwen, 2015a,b). The NBF developed here is designed to provide a national level of water management monitoring that includes the goals for Agenda 2030 and therefore the indicators used include those for the SDGs. It also includes complementary indicators that give additional reporting. For each of the chosen indicators a target was also chosen. This target was taken from those already present for the SDGs or a current EU target. For some indicators, there is no numerical target from within the SDGs or as an EU development target, and therefore a reasonable goal was chosen after assessing the scientific literature. This results in the final indicators being a progress-based indicator rather than a performance based indicator. The process is shown in Figure 3.

The indicators that could be complementary to SDG monitoring were identified in the answer to sub question 2 (Section 3.3), however, they must then be assessed and refined. To do this, they need to adhere to the following criteria. The indicators need to be simple so that they are useable and communicable to a range of practitioners, from industry, municipalities, governments and Non-Governmental Organisations. They achieve this by having the following key characteristics(European Commission, 2017):

- Easy to access
- Easy to understand
- Timely and relevant
- Reliable and consistent
- Credible, transparent and accurate
- Developed with the end user in mind

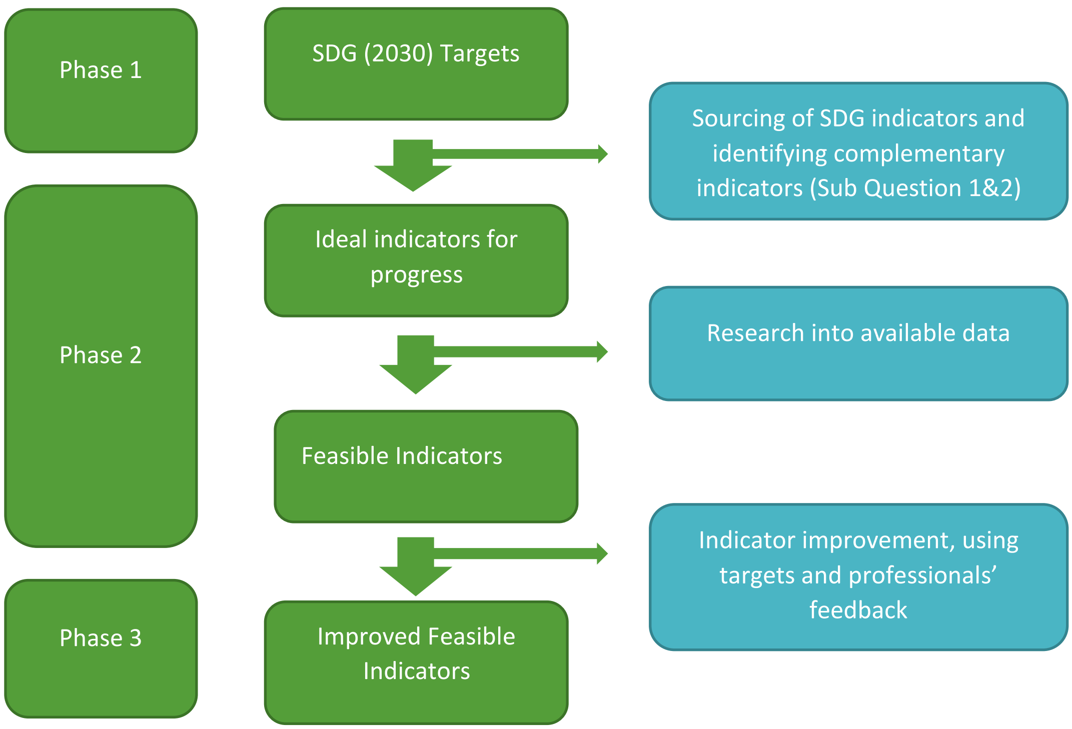

Figure 3 *Flow diagram of the indicator development.*

Whilst, the current SDG indicators have been used, the systems-based approach used by the SDG policy goals has been used to determine what should be the focus of additional indicators. Options for the indicators have been identified, however this approach aligns the indicator options with the targets.

The targets for the indicators were chosen in a hierarchical fashion – if the SDG target or goal had a numerical target this was chosen, if this was unavailable, but there was a numerical EU target or target specified by an EU country, this was chosen. However, some indicators have no target at national, European or global level and therefore an ideal target that would be required in achieving Agenda 2030 was chosen.

At present, some of the SDG 6 indicators have not been defined in a smart manner. To ensure goals are clear and reachable, indicators should be "SMART" (Koop & van Leeuwen, 2015a):

- Specific (simple, sensible, significant).
- Measurable (meaningful, motivating).
- Achievable (agreed, attainable).
- Relevant (reasonable, realistic and resourced, results-based).
- Time bound (time-based, time limited, time/cost limited, timely, time-sensitive).

Apart from this, the main bottleneck in the development of indicators is to find reliable input (data) to calculate the indicator scores. In this study the focus has been on countries of the European Union. This means that different specific sources of information can be used, e.g. data from Eurostat, data from the

European Environmental Agency, and data from the OECD. For non-EU countries data are generally scarce and indicator development and calculation, may be hindered and not be possible at all.

Some of the SDG 6 indicators are general policy goals. In order to make them "SMART" a further refinement is needed in terms of what we want to assess (assessment endpoints) and how we want to measure these (measurement endpoints). The associated indicators are then chosen based on the ideal measurement. An ideal measurement does not (yet) consider practical limitation such as data is availability. In the instance of good infrastructure, the associated 'ideal' indicators could be the age of the sewer or percentage of water leakage. These in turn, aid to the understanding of target 6.4.1, *change in water efficiency over time*.

Therefore, there are two sets of indicators chosen(Figure 3), the first is the ideal set of indicators – identified in this process. The second one is the set of feasible indicators, the selection of these is partially data driven as once the indicator was identified, the availability of data, from a reliable source, determined whether it could be selected. To determine whether water professionals would find the selected indicators useful, the proposed indicators were launched at the AIWW Summit 2018. This resulted in some alternative suggested indicators, as well as the suggested progress-based approach. From this, the final set of indicators and their calculation methods was defined.

3.5 Indicator calculation

Once the indicators had been identified, the data was then collected. The selected data was available as both continuous values and pre calculated numerical values. To be able to reach a final indicator value, two calculation steps had to be carried out. The first is to calculate the distance from the nation's current raw data value to the target value. This gives a value for the progression towards the target. Following this, the progression value is then converted to a value between 0-10 to give the final indicator value. The value of 10 indicates that the target has been reached.

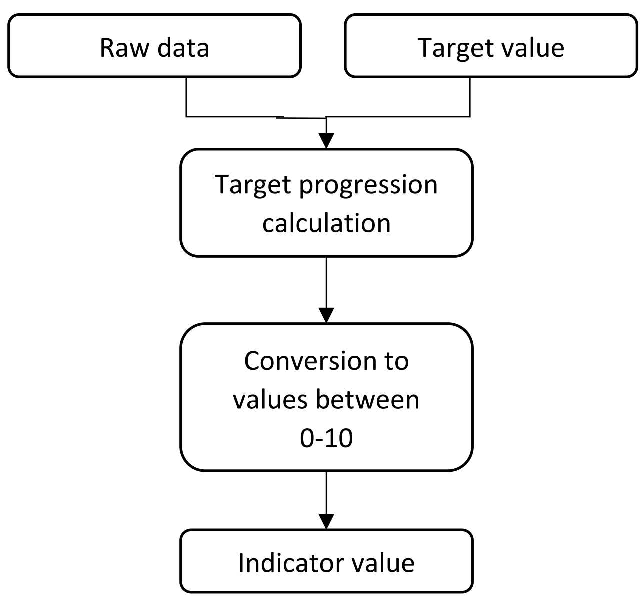

Figure 4. *Flow diagram to show the steps taken to reach the final NBF indicator score from the original data value.*

Given the range in data sources the calculations were not identical for every indicator. The following paragraph will show the general calculations, the individual calculations for each indicator can be found in Annex 1. The indicators have a value between 0-10, where 10 represents meeting the target and 0 represents either the lowest achievable value or scoring the defined least efficient value. This is outlined for each indicator in Annex 1.

In these examples raw data values in percentages, with an end target of 100, where A donates the raw data value, progression is the percentage value, and to convert to a value between 0-10 it is divided by 10.

In cases where the end target is 100% the calculation is shown below.

$$\mathbf{Indicator} = \frac{\mathbf{A}}{\mathbf{10}}$$

If instead the target is 0%, the following calculation is carried out.

$$\mathbf{Indicator} = \mathbf{1} - \frac{\mathbf{A}}{\mathbf{10}}$$

For continuous values, or those in percentages where the target is a value other than 100, the values are multiplied by a conversion factor to result in a range between 0-10, where scoring 10 means that the target has been reached.

In the following example A gives the national raw data value and B gives the target value. C is the conversion factor.

$$\mathbf{Indicator} = \frac{\boldsymbol{A}}{\boldsymbol{B}} * \boldsymbol{C}$$

If the indicator calculation included the progression towards a target value, a minimum-maximum calculation was used. With A being the minimum value and B being the target value and X being the country value.

$$\mathbf{Indicator} = \frac{(\boldsymbol{X} - \boldsymbol{A})}{(\boldsymbol{B} - \boldsymbol{A})}$$

Once the total number of indicators for a country had been collected, the geometric mean could be calculated to find the final index value of the NBF. The geometric mean is used in preference to the arithmetic mean as it reduces the impact of high or low scores. The addition of plus one to each indicator score means that indicators with a zero value do not result in an index score of zero. The approach is similar to the method developed by Koop and van Leeuwen (2015, a,b).

$$\mathbf{National\ Blueprint\ Index} = \sqrt[n]{(\boldsymbol{a_1} + \mathbf{1}) \times (\boldsymbol{a_2} + \mathbf{1}) \ldots (\boldsymbol{a_n} + \mathbf{1})} - \mathbf{1}$$

3.6 Framework Analysis

The third and final check for the indicators was carried out once the data had been collected. The check was to analyse the results and from this determine if there were any dependencies between the indicators and whether the resultant scores made sense. The CBF was used to check the scores as it was assumed, given that the NBF was developed a similar way, that there would be a linearity between the results. Additionally, many of the indicators for the two indices are the same.

To be able to assess the dependencies between the indicators an in internal indicator cross correlation was carried out. For this each indicator was measured against every other indicator and correlations compared.

The assessment of the scores and the applicability of the indicator was done by selecting the identical BCI and NBF indicators for the countries that overlapped. This also used Pearson's rank correlation coefficient. In this analysis, both the correlation of country level results and the correlation between two similar indicators was carried out. The country level results were assessed to see if the end result showed a similar pattern to those seen at a city level. The correlation between similar indicators was used to assess what affect the indicators had on the final result, and whether they also had appropriate end results.

The correlation analysis used the Pearson calculation as it is applicable for this calculation because the dataset is linear and normally distributed.

The Pearson correlation calculation (r) value is the difference between two variables. The r value ranges from -1.0 for negative correlation, and 1.0 for a positive correlation. A value of 0 denotes no correlation between the two variables.

Once the framework analysis had been completed, the final indicators had then been assessed to identify a set of complementary indicators for the SDGs within the given time frame and limitations of data availability and appropriate indicator numbers.

3.7 Assessing the national representation

To assess the degree to which the NBF is representative of the whole nation, the results of the NBF was assessed against multiple city level results for that country. This answers sub-question 4: '*To what extent does the proposed index represent regional variety within European countries and non-European countries?*'

To do this, countries where multiple cities had been assessed using the CBF were selected. The similar indicators where then identified for both the CBF and NBF. This meant that only the results of the corresponding indictors were being compared. Once this was completed, the Pearson correlation coefficient was taken for each city again the national indicator of the country that the city was from. This showed the variation of the city level results from the national level results. A negative value or a 0 value would suggest that the national indicator was not representative of the regional variety within the country and therefore not appropriate to be used on a national level.

4. RESULTS

4.1 Indexes for Water management

The review of IWRM frameworks showed that the current IWRM indicators are numerous and because of this also cover a broad range of end goals. This scope includes whether they focus at a city level of water management such as the City Blueprint Approach(Koop & van Leeuwen, 2015a,b) or a basin level approach seen in the Canadian Water Sustainability Index (Policy Research Initiative, 2007), or at a national level such as the Global Water Security Index (Gain et al., 2016)

Additionally, the range of end goals relates to the area for which the index was created. The Canadian Water Sustainability Index is developed specifically for water management in Canada, whereas other basin level approaches such as the Transboundary Water Assessment Programme (TWAP) is developed for use internationally. In this way, the selected indicators are optimized for a specific location.

Furthermore, the methodological approach to the indicators is diverse. Some require data made available at a national level, other depend on gathering data via questionnaires.

The point at which the subject areas is measured can also differ, the indicator can measure the preventative steps in place, such as good governance and management frameworks, or investment in infrastructure (BCF and ADB), or at a current situation point, such as the age of sewer, or the final resulting situation, can be measured such as the amount of water leakage.

Table 2 *The Indicator frameworks chosen included within the indicator database.*

Indicator Frameworks	Source
National Water Management Index	(Asian Development Bank, 2016)
Blue City Framework	(Koop & van Leeuwen, 2015a,b)
Canadian Water Sustainability Index	Government of Canada (Policy Research Initiative, 2007)
City Resilience Index	(Arup, 2014)
Environmental Performance Index	(Yale, 2018)
Global water security Index	(Gain et al., 2016)
Sustainable City Water Index	(Arcadis, 2016)
SWESES	(SDEWES, 2017)
TWAP-rivers	(Niasse, 2006)

Of the total IWRM frameworks identified in the literature review, nine were selected (Table 2) as the most relevant for further exploration into the indicators used. This yielded a database of 186 indicators that are currently used for IWRM. From the total of 186 indicators, only 13% of these were used more than five times. The most common indicators included access to water, access to sanitation, drinking water quality and the level of secondary wastewater treatment. Whilst indicators assessed were predominantly performance related indicators, which measure the current state, the approach of the IWRM Indices depends on what they wish to achieve. For example the Sustainable City Water Index has indicators for water balance and water reserves (Batten, 2016) as these monitor how well a city manages water in a sustainable manner to not over consume resources. Conversely, the TWAP Index does not contain these indicators but has indicators such as political tension and legal frameworks within the river basin. This is due to the indicator measuring the impact of the water course being a transboundary resource and therefore includes the risk of potential resource conflicts. Both the TWAP Index and the Sustainable City Water Index contain an indicator for Water Stress as this relates both to sustainability and the potential for conflicts.

When the IWRM indicators were compared to the indicators used for SDG 6, there was very little overlap with only 28% of the indicators in the IWRM indices also being used for SDG 6. The indicator for the degree of IWRM implementation (SDG 6.5.1) was not measured at all. However, the indices did contain indicators such as 'management and action plans' or 'effective management' which are less specific indicators of resource management. The lack of this indicator may be due to the indicator frameworks being used as part of an IWRM management plan, for example the Canadian Water Sustainability Index, and therefore it was not relevant to include IWRM implementation as an indicator.

Change in water-use efficiency, water stress and the transboundary water cooperation agreement indicator (indicators 6.4.1, 6.4.2 and 6.5.2 respectively) were also lacking from many of the indices and each only occurred twice. The reason for the lack of inclusion may be due to multiple different facts such as lack of data availability, aggregation of data and a lack of perceived value. The efficiency of water use requires data to be gathered over a number of years, which may have only recently begun. The transboundary management may have been included within the other management indicators and not disaggregated into a separate indicator.

4.2 Alignment of the SDGs with current IWRM indicators

The next section shows the alignment of currently used IWRM indicators with the SDG targets and SDG indicators.

Each IWRM Index is designed for a different setting, with those designed for flood risk areas or less developed, having indicators specific for that level of development. However, there are some indicators that are deemed to be important in multiple locations. These indicators also align with those required for SDG indicator monitoring. Of the 186 IWRM indicators assessed, only 20% were indicators that were also used in the SDGs. Of these, 78% included access to water within their index, however the only disaggregation of this indicator is between the access to drinking water and the drinking water quality. The second most common indicators, present in 67% of Indexes were access to adequate sanitation and proportion of wastewater safely treated. For most of the indices, this included any wastewater treated with secondary or higher level of wastewater treatment. Only the CBF included further disaggregation. The presence of good ambient water quality was measured in the indices by the groundwater quality. However, water quality, measured in the environment was an uncommon indicator and only occurred in 33% of indices. The SDG indicators that were least represented were change in water efficiency over time and level of water stress. These were present in only 22% of the indices. As seen in Figure 5 there are some significant gaps in the SDG indicators that are also found in IWRM indexes. This highlights that there is a lack of available data for the specific SDG indicators, rather than that they are deemed unimportant as, other indicators are used that still align with the SDG targets.

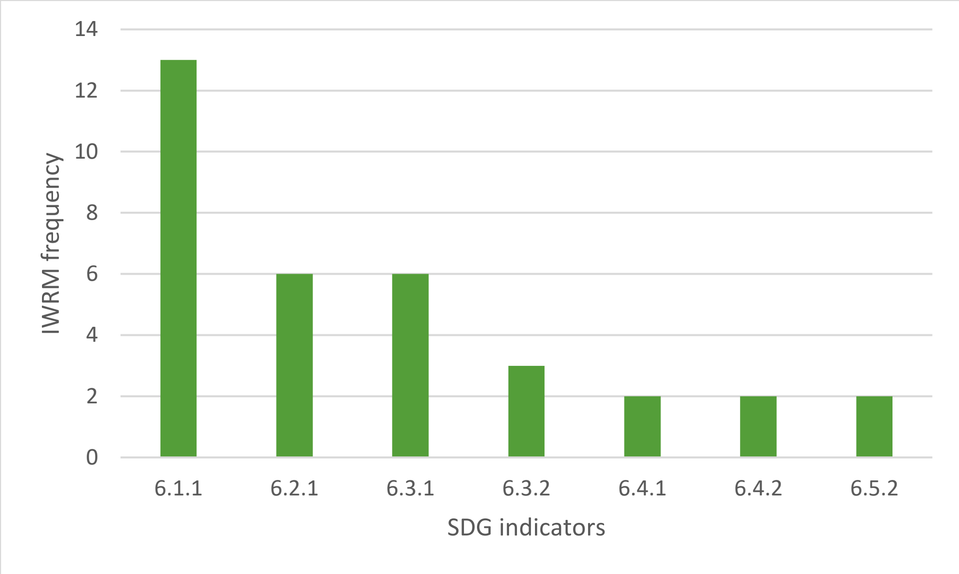

Figure 5 *Number of IWRM indicators that align with the SDG indicators.*

The number of IWRM indicators that show correlation with the targets shows an inverse distribution to that of the correlation with the SDG indicators. In total 66 indicators correlated with the SDG targets compared to only 38 indicators that correlated with the SDG indicators. A high number of indicators are relevant to SDG targets 6.3 and 6.4, 15% and 12.5% respectively, but the specific SDG indicators are not commonly used. There is a smaller range of indicators that align with targets 6.1, 6.2 and 6.5 as seen in Figure 6. Of the total number of indicators that aligned with the SDG targets only 10% aligned with target 6.1, 9% with 6.2 and 8% for target 6.5. The indicators that aligned with 6.1 and 6.2 were identical for all indexes and were used by 78% and 68% of indexes respectively. This suggests that there is a high amount of data availability for the desired indicator and that there is cohesive thought in what indicator is needed. The lowest number of target and indicator synergies was seen with target 6.5. From the total number of indicators assessed only 4% correlated with desired outcomes from target 6.5. The indicator only occurred in 44% of the total number of indexes assessed, and in one index, an indicator that aligned with target 5 occurred twice. This may be due to a lack of data or that water management is not perceived as an ideal IWRM monitoring measurement.

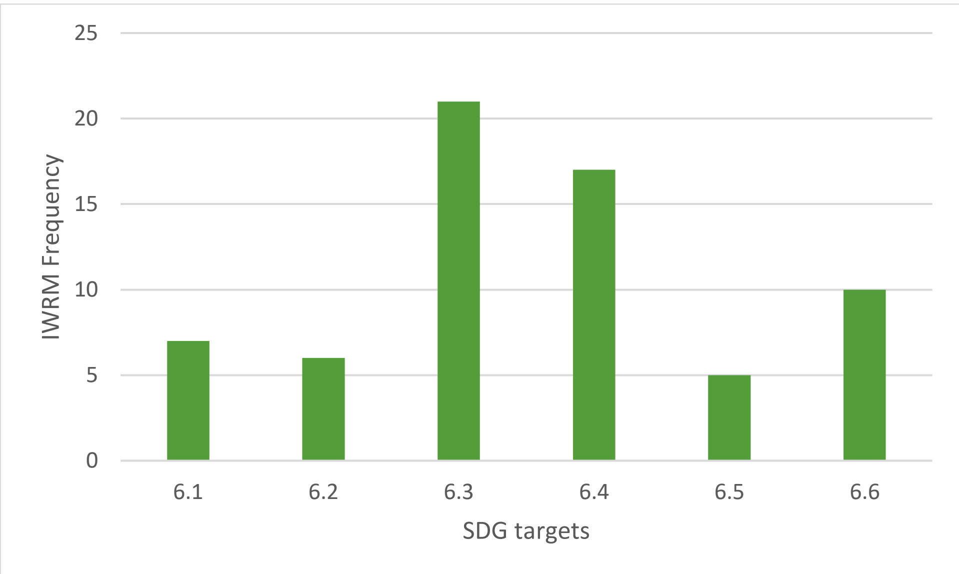

Figure 6 *Number of IWRM indicators that align with the SDG targets.*

From the analysis of the indicator database created in answer to sub question 1, there is limited alignment between the SDG indicators and targets and the indicators produced for IWRM. This is in part due to the fact that there are only 11 indicators for SDG 6, whereas all of the IWRM indicators assessed had greater than 15 indicators. The fact that only 28% of indicators align with the SDG indicators is in part due to their being more indicators per index initially. This is supported by the increased alignment of IWRM indicators with the SDG targets at 49% of indicators aligning. Where there is a lack of indicator alignment, an increase in target alignment is seen. This suggests that where there is a lack of available data the water management professionals find varying indicator alternatives for the same area of water management. This indicates that the themes seen as being required to monitor water management are cohesive between water professionals and those who designed the SDGs.

4.3 Indicator Development

The following section describes the framework developed in this study including the selection of the feasible indicators including their associated targets. From here the results of the indicator trial for the EU will be discussed, including the comparison with other indicators for results reliability and finally the applicability of the index to be used as a global indicator.

4.3.1 Indicators selected

From the analysis described in chapter 4.2, we saw that the SDG indicators have only 11 targets for SDG 6, from the analysis found in chapter 4.2 whereas 66 IWRM indicators aligned with the targets. This suggests that there are many areas where complimentary water indicators would provide further information on the progression towards achieving the SDGs. The IWRM indicators were used to provide a set of possible indicators for each target. From these an 'ideal' set of indicators was selected according to the best options for measurement end goals. However, due to data availability, not all these indicators were able to be used and therefore a second set of feasible indicators was created for which data is available, this is shown in Table 2. The limitations in data availability were primarily in monitoring water efficiency and climate mitigation measures. A reliable data source was also necessary, the most readily available indicators were those collected by the UN due to its global coverage and reliability. There was a lack of data for water quality and water infrastructure management. Other indicators that were lacking or difficult to source include those for progression towards a circular economy. In some cases, such as water leakage, calculation from the available data can provide a proxy indicator for this measurement.

Once completed, the set of feasible indicators was then sent for review by water professionals to check their opinion on the indicators relevance and meaningfulness. This was part of the check to determine whether the indicators met the SMART requirements mentioned above. The indicators suggested by the review team included ecological water quality being separated from the surface water quality indicator as well as the inclusion of an indicator for water affordability. The final set of feasible indicators is seen in Table 3.

Table 3 – *Feasible indicators for the NBF. See Annex 1 for calculations and further reasoning.*

Category	Indicator	AIWW targets*
Water stress	1. Water scarcity	M,U,I,F
	2. Flood Vulnerability	M,I
	3. Transboundary cooperation	M
	4. Tertiary education attainment	M
Water quality	5. Surface water quality	M,U,I,
	6. Groundwater quality	M,U
	7. Ecological water quality	M,U
Access to basic services	8. Drinking water quality	U
	9. Drinking water connection	U,I
	10. Sanitation connection	U,I
	11. Water affordability	M
Infrastructure	12. Infrastructure Investment	M,U,I
	13. Water leakage (%)	M,U,I,F
Wastewater treatment	14. Secondary WWT (%)	M,U,I,F
	15. Tertiary WWT (%)	M,U,I,F
	16. Nutrient recovery (%)	M,U,I,F
	17. Waste Water to Energy	M,U,I,F
Solid waste treatment	18. Solid waste generated	M,U
	19. Solid waste recycled (%)	M,U,
	20. Solid Waste to Energy (%)	M,U,I,F
Climate adaptation	21. CO2 emission per capita	M,U,I,F
	22. Renewable energy % total	M,U,I,F
	23. Notre Dame Readiness Index	M,U,I,F
	24. Integrated Water Resources Management	M,U,I,F

* Targets are Municipalities (authorities; M), Utilities (U), Industry (project developers/investors; I) and the Financial sector (investors; F) This needs further discussion with all stakeholders.

The Indicators have been assessed as the progression towards achieving the SDGs. To be able to show the amount of progression each indicator is required to have an end target. The Targets and Goals developed for agenda 2030 lack numerical targets. Target 6.1 and 6.2 include the phase 'access for all' which has been assumed to mean 100% coverage. Target 6.3 aims to 'improve water quality' without a numerical target given and 6.4 aims to 'substantially increase water-use efficiency'. Whilst this means that countries with different levels of development can all aim to achieve the targets, it does not provide a goal to aim for. For indicators with no clear goal, the next step was to check European targets. Only 16% or the indicators have useable SDG targets, compared to 38% of indicators for which there was an EU target. The remaining indicators have targets supported by literature. Table 4 summarises the targets chosen for each NBF indicator.

Table 4 *Targets for each indicator and their reasoning.*

Indicator	Target	Reasoning
1. Water Scarcity	20% of renewable water sources	The 20% of renewable source is the indicator set by the EEA of what is a sustainable amount of extraction. Achieving this indicator ensures sustainable rates of water extraction.
2. Flood Vulnerability	Low risk	With the increased risk of flooding for Europe, the target for achieving Low flood risk would indicate sufficient flood prevention investment.
3. Transboundary cooperation	Low Risk	Ensuring that all rivers gain a score of 1 regarding the Legal agreements for transboundary rivers according to the TWAP research assessment
4. Tertiary Education Attainment	40% of 25-64 year old	The EU target is 40% of 30-34 years old individuals have tertiary level education, due to data availability, the age spectrum has been widened.
5. Surface water quality	Good score	The target is progression towards achieving a good score according to the WFD.
6. Groundwater quality	Good score	The target is progression towards achieving a good score according to the WFD.
7. Ecological water quality	Good score	The target is progression towards achieving a good score according to the WFD.
8. Drinking water quality	100%	This indicates that the quality of water supplied is good for human consumption without further filtering.
9. Drinking water Connection (%)	100%	Indicates the population connected to a drinking water supply within their home.
10. Sanitation Connection (%)	100%	This indicates the percentage of the population connected to safely managed, non-shared sanitation facilities. The highest level of sanitation measurement by the JMP for the SDGs.
11. Water affordability	100% affordable <4% income	Whilst increasing water tariffs is a way of reducing water consumption, this indicator monitors whether the water remains affordable for the population.
12. Infrastructure investment	3.8% GDP	In order to ensure current infrastructure is maintained and developed, the level of infrastructure investment needs to be 3.8% GDP according to McKinsey & company.
13. Water leakage (%)	0%	This indicates the quality of water infrastructure. 0% leakage would indicate efficient water usage.
14. Secondary WWT (%)	100%	The indicates the number of countries that have reached secondary Wastewater Treatment (WWT)
15. Tertiary WWT (%)	100%	This indicates those countries which are improving their water usage to allow reuse and fit with the target of achieving a more circular economy.
16. Nutrient recovery (%)	100%	This indicates the amount of nutrients reclaimed from the used water. For a circular economy to be achieved all nutrients must be recovered.

17. Wastewater to Energy	100%	This indicator shows the development of energy capture from wastewater. This can show developments in the standard of wastewater processing, and energy efficiency of the water cycle.
18. Solid waste generated	10% less than 2010 levels	The target for Europe is to prevent waste being produced, as well as to increase recycling. The target of 10% less waste produced than 2010 quantities is the Spanish target for 2020 and has been set as the European standard.
19. Solid waste recycled (%)	65% total	This indicator shows the progression towards the EU 2030 recycling target.
20. Solid Waste to Energy (%)	100%	This indicator shows the progression towards achieving a circular economy by gaining energy from waste.
21. CO2 emission per capita	32% of 1990 levels	The current European target s to reduce the CO2 emission to 27% lower than 1990 levels.
22. Renewable energy % total	32%	The European policy to reduce waste by 2030 includes a recycling target of 40% of total waste by 2030. This indicator can also show progress towards material use for the circular economy.
23. Notre Dame Readiness Index	100%	The Notre Dame Readiness Index scores progression towards readiness to climate change. The highest level of 'readiness' is 100.
24. IWRM	100%	The percentage of integrated water management strategies. This shows progression towards SDG target 6.5.1.

4.3.2 Linking the selected indicators with the SDGs

Each of the indicators aligns with a specific target, some of the indicators are developed from the SDG indicators for which there is data available, the remaining indicators are complementary. The alignment of the indicators with the SDG targets can be seen in Table 5. Annex 2 contains the link between the complementary indicators and other SDGs is shown for each complementary indicator. The table highlights the reason the indicators can be used to measure progress towards more than one goal. By including complimentary indicators, development in only one region will not result in a higher score within the index.

Table 5 *Goal 6, Links between key NBF indicators and complementary indicators and Goal targets.*

NBF Indicators	SDG Direct Goal Link	Indirect SDG 6 Link	SDG Goal interlinkages
1. Water scarcity	6.4.2		16, 8, 2
2. Flood Vulnerability			15, 13
3. Transboundary cooperation		6.5.2	17
4. Tertiary Education attainment			4, 9
5. Surface water quality	6.3.2		15, 3
6. Groundwater quality	6.3.2		15
7. Ecological water quality	6.3.2		3, 15
8. Drinking water quality	6.1.1		3, 2
9. Drinking Water Connection		6.1	3, 15, 5, 4
10. Sanitation connection			3, 5

11. Water affordability			1, 10
12. Infrastructure Investment		6.2	9
13. Water leakage (%)		6.4	9, 11, 12
14. Secondary WWT (%)	6.3.1		3, 11
15. Tertiary WWT (%)		6.3	3, 11
16. Nutrient recovery (%)			11, 12
17. WasteWater to Energy			7, 11
18. Solid waste generated			11
19. Solid waste recycled (%)	12.5		11, 13, 12
20. Solid Waste to Energy (%)			7, 11, 12
21. CO2 emission per capita			13
22. Renewable energy % total			7, 11, 13
23. Notre Dame Readiness Index			13
24. Integrated Water Resources Management	6.5.1		17, 12

4.3.3 Indicator results for the EU

Once the framework had been developed the data was collected for the EU 28. The following section provides the results of the indicator scores. The information is provided in detail in Annex 3 and summarized in Figure 7 below.

The results show that in total, there needs to be more progress towards energy and nutrient recovery in order to progress towards having a circular economy. There is an overall high score for drinking water and sanitation connections, however in some countries with generally lower scores, there is a trend for sanitation to score lower that drinking water connection. The lowest overall NBF score was Malta, and the highest overall NBF index was Finland. Malta also has the largest deviation in the indicator results whereas France has the most consistent scoring. The graphs for the results can be found in Annex 3.

For the framework to be useable, it needs to clearly show the differences between the countries tested. To check this the standard deviation of the results was taken (Figure 7). The indicator that showed the highest variability among the EU 28 was Tertiary education. The score with the least variability was the Drinking water quality. This may be due to the global scale of the Notre Dame Readiness Index compared to the solid waste generated, which was progress towards reducing waste generation from 2010 levels. Other indicators that show low variability include the connection to drinking water supply and drinking water quality. Across the EU, both of these indicators score highly and therefore there are few low score to increase the indicator score range.

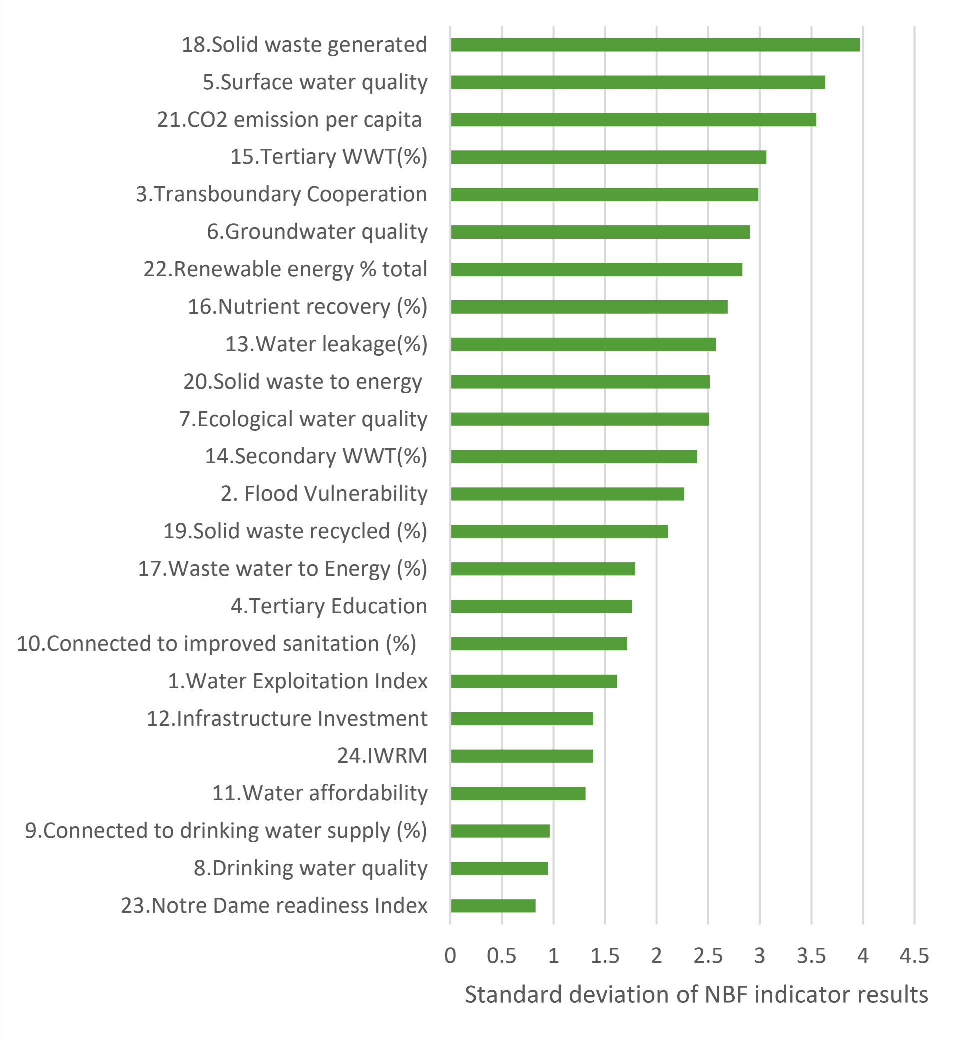

Figure 7 *Standard deviation of indicator results among the EU 28.*

The indicators were also correlated against each other to ensure that there are no dependencies between the indicators chosen (Figure 8). The risk with dependencies and cancelling effects is that improvements towards one indicator would have negative impacts on progression towards another indicator. The final results table is seen in Annex 4.

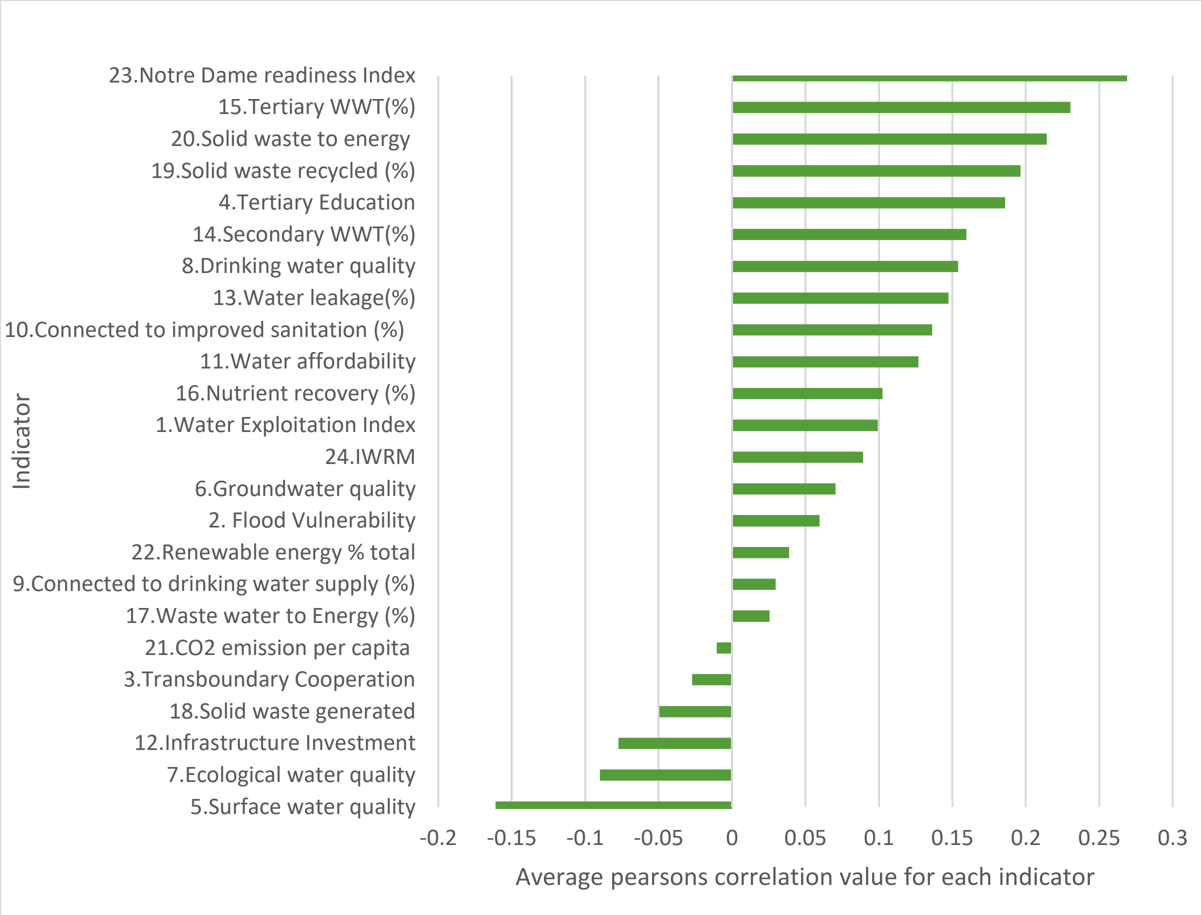

Figure 8 *Average Pearson's correlation coefficient for the intra-indicator correlation assessment.*

The indicator that had a positive correlation with most other indicators was the Notre Dame Readiness Index, which had the highest average correlation score but also had the highest score with a specific index. This was a score of 0.7577 between the Notre Dame Readiness Index and Solid waste recycled (%). This was higher than the correlation value of 0.7409 between the Secondary and Tertiary WWT indicator. The surface water quality score shows a high average negative correlation. This is due to the negative correlation that it shows with 58% of the indicators.

4.3.4 Country results

To test whether the framework produced credible result the result of one country was assessed again that same countries results from another IWRM framework. This test was carried out for every EU country for which there was available results. When the results of the two countries are compared a strong positive correlation would suggest that the results of indicators were very similar. The BCF was used as a comparative index as it has a large number of similar indicators. In total there were 11 indicators that are the same between the two frameworks. Scores have been calculated for 18 of the same countries with both of them. The average score from cities was used as a comparative score with the national scores calculated in the NBF.

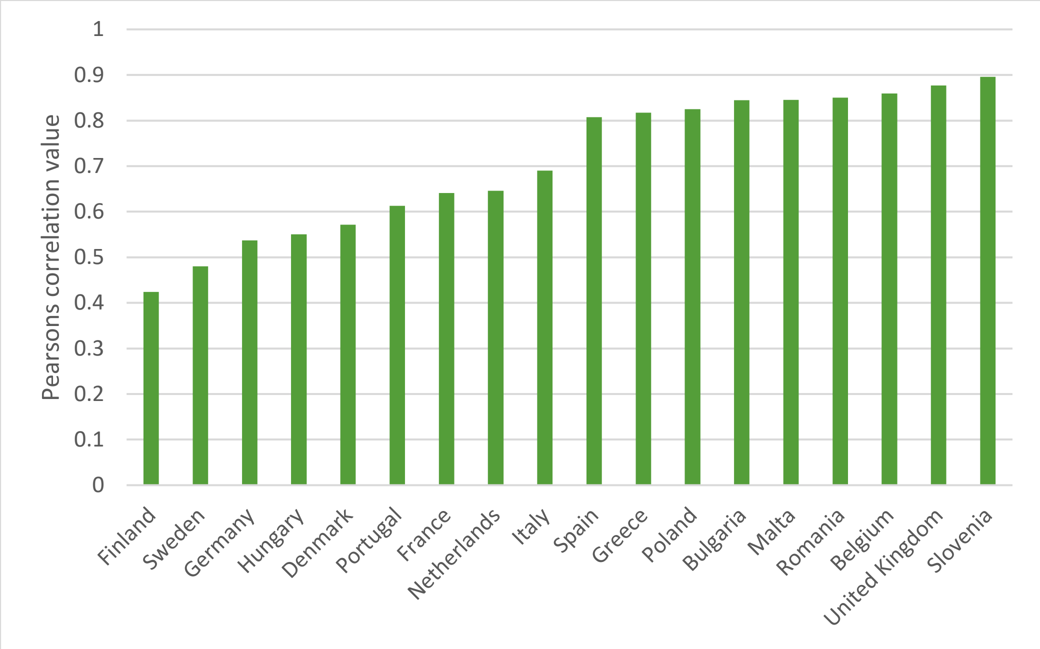

Figure 9 *Correlation between country results of the BCI and National Blueprint Index (NBI).*

From the country level correlation analysis, it is seen that over 50% of the results have a positive correlation score of above 0.8, 89% of the indicators have a correlation of above 0.5. This suggests that the city level scores are representative of the results given by other water management Indexes.

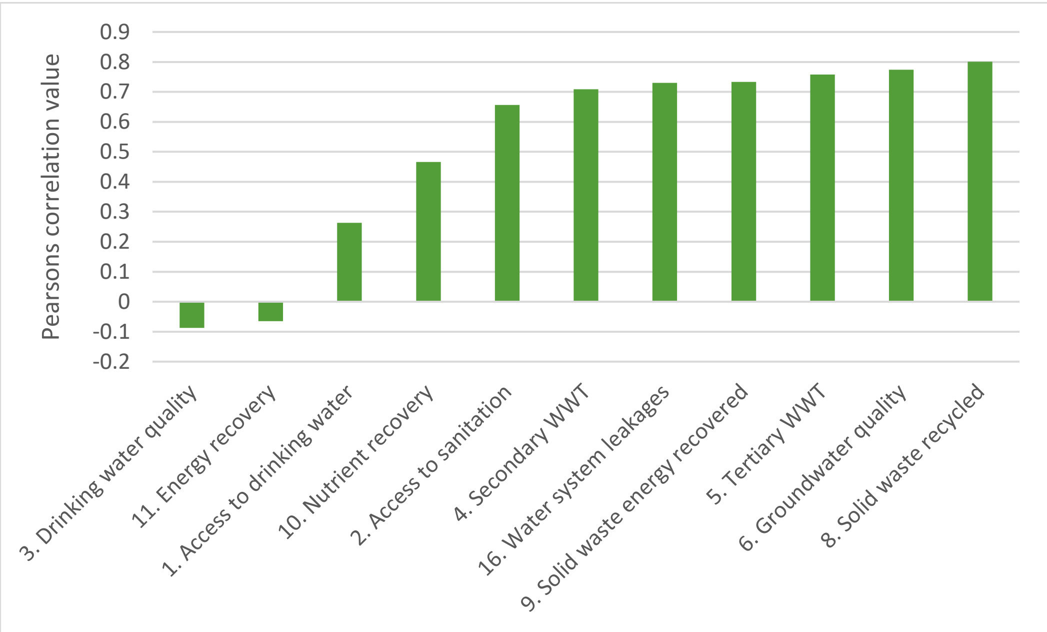

Figure 10 *Correlation between the indicators used.*

To further determine the effect of each indicator on the country correlation values seen above the scores of the indicators were correlated against each other. In this analysis, shown in Figure 10, the final scores are lower than those seen between the cities. Only one indicator, solid waste management, has an r value of above 0.8. However, 64% of the 11 indicators analysed had a positive correlation r value of above 0.5.

4.3.5 Application of the NBF to non-EU countries

The National Blueprint framework was then applied to non-EU countries to test its global relevance. In doing so, some problems were highlighted, the results of the application are discussed below.

The largest problem found in applying the framework was the lack of data availability. In total the data for 16 indicators could be found for South Korea and the United States, with only 13 indicators having the required data for Tanzania this number decreased to only 12 for Brazil. The larger number of indicators found for South Korea and Brazil was due to them being part of the OECD and therefore present in those datasets.

In some cases, alternative proxy indicators were used, such as for water access to drinking water, the EU countries used 'proportion of the population using improved water supplies' which were under the category of 'safely managed' from the World Health Organisation (WHO). However, for South Korea, Brazil and Tanzania, there was no data available for 'safely managed' and instead, 'piped' category was used instead.

In other instances, the data was not available from the source used for the EU and was instead found from other data sources, these are displayed in Table 6.

Table 6 *Alternative indicator sources used for non-EU countries.*

Indicator	Alternative Source
Tertiary Education	World Bank
Water Leakage (non-revenue water)	IB-Net
Secondary Wastewater Treatment	IB-Net

To compare index scores of the non-EU countries, the indicators for which every country had data were separated. From the indicator scores, the geometric mean was calculated to create an index for every country. The Index scores were then ranked from 1 (being highest) to 32 (being lowest). South Korea ranked 28th but the United States, Brazil and Tanzania ranked 30th, 31st and 32nd respectively.

4.4 Representation by the national index

The following section gives the results of the degree of representation by the national index throughout the country it represents.

A comparison of the United Kingdom and the Netherlands shows that the correlation between cities and countries varies between countries. For the United Kingdom, London and Leicester have a higher correlation with the national indicator than eastern cities such as Bristol and Bath. The Netherlands shows a greater range of correlation values with Amsterdam having a negative correlation value of -0.3 and Groningen having a correlation value of 0.7. None of them reach as high correlation scores as those seen for London and Leicester.

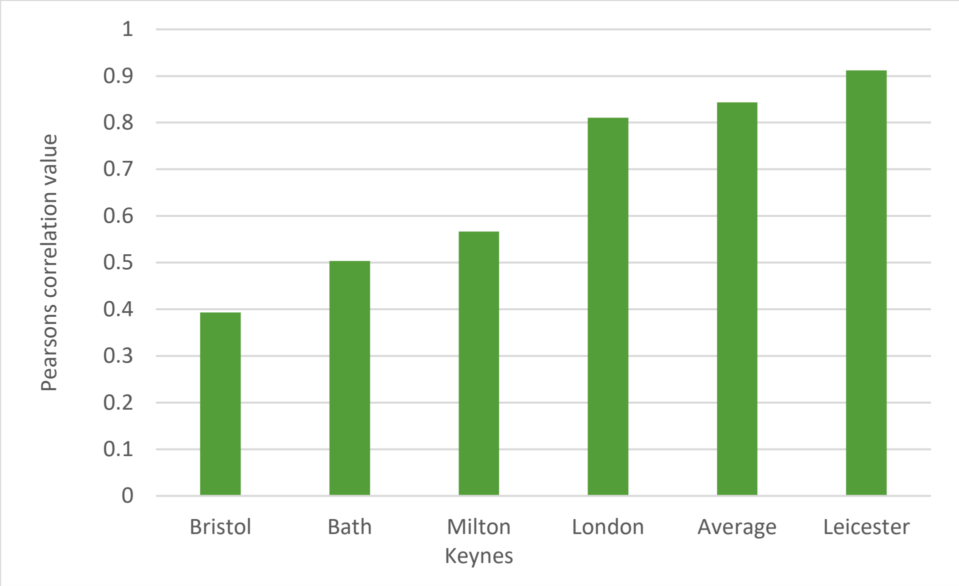

Figure 11 *Pearson correlation between UK BCI results and the National NBI. Average denotes the mean average UK value from BCI results.*

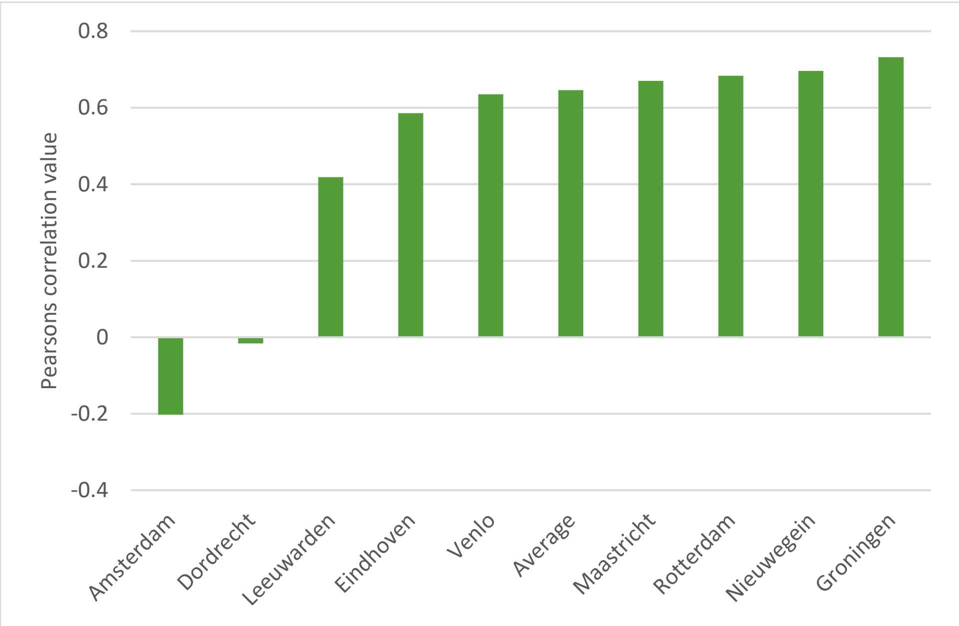

Figure 12 *Pearson correlation between the Netherlands BCI results and the National NBI. Average denotes the mean average Netherlands value from BCI results.*

5. DISCUSSION

The NBF is a set of progress-based indicators that show the progression of EU countries to achieving the SDGs, it has also been assessed for its relevance for non-EU countries. The indicators chosen stem from current IWRM indicators, including those for the SDGs. The set of proposed water-related indicators reaches a total of 24 indicators that are grouped into seven categories.

5.1 Reliability of the results

The data for the indicators has been chosen from reputable sources to improve its reliability. Primarily the data was sourced from the Worldbank, OECD, Eurostat and UN databases. For some indicators the data was less easily available for a specific country for example, surface and groundwater quality (NBF indicators 5, 6 and 7) data was lacking for Greece, Ireland and Lithuania in the EU dataset and so was taken from the respective national reporting datasets.

The IWRM frameworks that were assessed in this research were identified for different reasons. A selection was made on which frameworks were cited in scientific literature. Others that were used by reputable water professionals were also included. These are assumed to be relevant and have a rigorous scientific approach.

Some other factors regarding the reliability of the results are for instance that in calculating the indicators some assumptions were made regarding to the applicability on a national scale. For example the Water Affordability indicator (NBF indicator 11) assumes that a household is comprised of two adults and two children, further details of the indicator assumptions are included in Annex 1.

Due to the volume of indicators available and the time constraints of the project only nine IWRM which allowed better quality more in depth analysis of the frameworks. These indicators contained 186 indicators, but only 35% were relevant to the SDGs. For future research, to be able to identify indictors more accessible to the global south, analysing frameworks located outside Europe would be beneficial. At present only three non-European indicators were included and only the National Water Management Index was not developed for Europe or North America.

Also, whilst 186 indicators were reviewed and used as a base for the framework development, the range of indicators that could actually be included in the framework was limited by data availability. The main area in which data was lacking for the desired indicators was for those relating to the circular economy. Although waste to energy plants exists, and nutrient recovery from wastewater is occurring, there is little easily accessible data available to monitor this on a large scale.

Similar data exists which have small collection variations, which limits the extent that they can be used for the same indicator. A report by EurEau (EurEau, 2017) measured the distribution losses from water infrastructure within the EU. The International Benchmarking Network for Water and Sanitation Utilities (IBNET) also has an indicator for non-revenue water distribution. For the creation of the NBF, the EurEau data was used as it was available for the majority of the EU countries, compared to IBNET which only contained data for 10 EU countries. However, in assessing the feasibility of the NBF as a globally applicable monitoring framework, the IBNET data set could be used as it has global coverage.

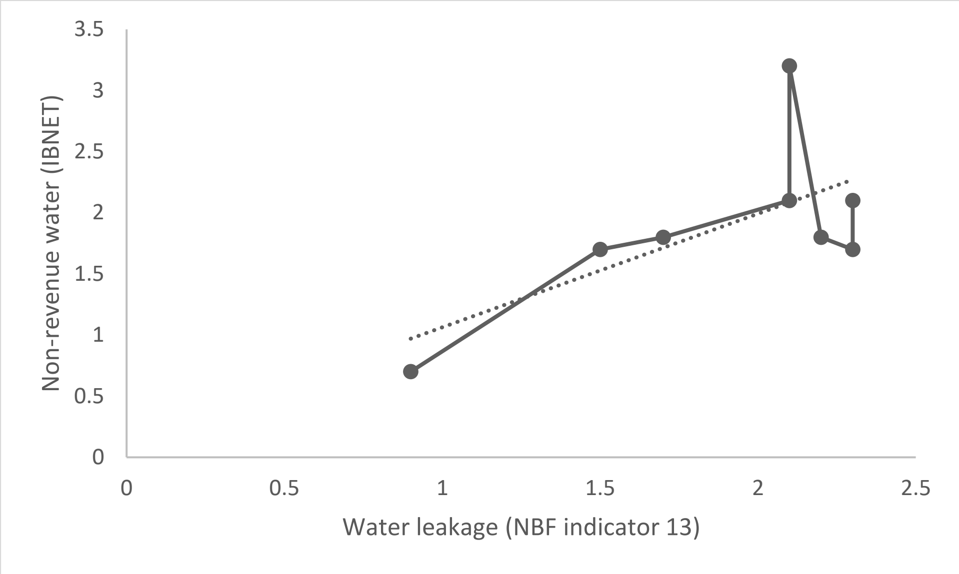

Figure 13 *Correlation between the values given for indicator 13 from the EurEau and IBNET.*

To assess whether this was a feasible alternative data source, the Pearson correlation was taken between the overlapping countries of both datasets. This gave a large r value of 0.67, the two data sets have similar results apart from Hungary (Figure 13) which has a value of 32% losses with IBNET and only 21% losses recorded by the EurEau. If this value is ignored the r value is 0.84. This suggests that IBNET can be used as an alternative data source for non-EU countries for this indicator.

Even when the data set contained data for every country, there were instances where there was no recent data available for every country. However, in order to ensure that the index remained as up to date as possible, the most recent *available* data was used for each country, This was especially the case when the framework was applied to non-EU countries, with Tanzania having the most recent data being 2012 for solid waste generate (NBF indicator 18). As the framework measures progress towards a goal, it is unlikely to show relevant progress if the goal was set after the last measured data sample. Additionally, using different years means that comparisons between countries may not be as accurate.

5.2 Discussion of the results

The aim of the indicator framework was to develop on those already proposed for SDG monitoring and provide complementary indicators. The popularity of indicators for policy implementation has led to an extensive use of indicators for a wide range of contexts (see Table 2). The work done within the thesis builds on previously created indicators. The initial search showed that indicators frameworks had been previously reviewed, in terms of their applicability for sustainable cities (European Comission, 2015; Hoekstra, 2018) as well as their usability as a sustainability indicator (Pires et al., 2017). However, there was a lack of information of frameworks applied at a national level. To develop an overview of national level IWRM frameworks, a separate review was therefore carried out within this thesis.

When the IWRM indicators were compared against the SDG indicators it became apparent that indicators that had been used within the MDGs, such as access to improved drinking water (MDG 7) were more popular than those not included such as water efficiency (SDG 6.4.1) and water management (SDG 6.5.1) (Figure 5). For those already collected as part of the MDGs, it is likely that there is already easily accessible data available for these indicators and hence the wide usage of specific indicators. This suggestion is supported by the results of the correlation of the SDG targets with the IWRM indicators. The use of a wide range of indicators used for targets 6.3 and 6.4 (Figure 6) supports this idea as it suggests that the indicator subject is still viewed as relevant for monitoring.

The inclusion of targets for the indicators allows the measurement of progress towards a goal rather than the current performance of the nation. Showing progress towards a goal increases the use of the indicator as policy makers can discern whether they are on track to meet a target. Whilst the SDGs have 169 targets, very few of these have precise numerical goals. For those targets that did have numerical goals, these were chosen as the end target of the NBF. The Sustainable Development Scenarios discussed at the Rio+20 United Nations Conference on Sustainable Development equally do not have many specific numerical targets for water and those that do, such as the target to give another 230 million people access to an improved water source (United Nations Department of Economic and Social Affairs, 2013) is a target on a global rather than national scale and therefore difficult to apply nationally as the target is not relevant to every nation.
This led to the use of EU indicators where they were available. The use of EU indicators means that some of the indicators were not available to use for other nations such as the target of 'good' status (defined by the EU) for water quality. For some indicators there was no SDG or EU target. These indicators were those measuring new technologies or those specific to the management of water systems. This included the indicators for increasing water use efficiency (*water leakage*-NBF indicator 13 and *infrastructure investment*-NBF indicator 12). As well as those for resource reuse such as nutrient and energy recovery from wastewater (NBF indicators 16 and 17 respectively). The targets for these indicators were far more idealistic that the targets set by the EU for alternative goals. However, If the circular economy is to be realised by 2030 in Europe, then adequate data needs to be reported and these chosen targets should be achieved.

The aim was for the framework to be representative of the nation of which it is monitoring, the results of the correlation analysis (Figure 11 and Figure 12) show that the NBF has a strong correlation for both the Netherlands and the United Kingdom (r=0.65 and r=0.84 respectively).

When scaling down on regional scale it was found that for Amsterdam there is a low negative correlation with the NBF. This may be due to the fact that Amsterdam scores the highest or the top score in 10 of the 11 indicators suggesting that its water infrastructure is more advanced than other areas of the Netherlands. The pattern is less obvious with the lower correlation of the CBF for Bristol and Bath with the NBF for the UK. However, they both score the highest or top score for seven of 11 indicators, although not for the same indicators. For both countries, the low correlating cities have high nutrient recovery scores compared to very low scores for the rest of the country. This suggests that the CBF comparisons can highlight cities that may be overachieving in terms of water management compared to the national average, and therefore this framework can be used alongside the national framework to identify internal areas of achievement.

The SDGs are designed to be implemented on a global scale and as such, the indicators need to be applicable to every country. This is highlighted in indicators such as SDG 6.1.1 Proportion of population using safely managed drinking water services and 6.2.1 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water – in the EU, these average at 91% and 80% achievement respectively. Whilst there is still room for improvement, these indicators do not help to determine the cause for the lack of these services or the degree to which these services are efficient and sustainable. This supports the problem of the SDG indicators outlined in section 2.1. If disaggregated indicators where used instead, those countries scoring highly could identify where there is still room for improvement. This leads to the problem of not every country having the same starting point(Equal Measures 2030, 2019) with the global south having more progress required in social indicators whereas the global north has a greater focus on achieving the environmental indicators. The framework was developed from the SDGs but also a set of indicators that primarily were sourced from initiatives in the global north, this leads to a bias within the framework of indicators relevant to the state of development within the EU. The impact of this on the developed framework can be seen when it is applied to the non-EU countries where Tanzania scores 10 for renewable energy % (NBF indicator 22) but only 3.5 for Connected to drinking water supply (NBF indicator 9).

As well as the indicators being relevant to Europe, the targets too are based on the EU goals, and targets that could be realised in this situation. However, as not all countries have the same starting point, it would be unfeasible to assume they could achieve the same end goal in 15 years.

5.3 Further research

Further research is required regarding both data collection and target setting. There is currently a lack of data sources for appropriate monitoring for the circular economy within Europe. Additionally, the study highlighted the lack of data for non-EU countries. The risk of overstressing current national data collection means that an alternative collection method such as mobile data collection (Trucano, 2014) could increase data collection ability.

Alongside the acquisition of data, research is needed for more feasible targets for those indicators lacking SDG targets. Future targets could be taken from future scenarios and adapted as the situation that needs to exist in order to achieve the scenario, this would allow the development of targets for the circular economy.

6. CONCLUSION

In this thesis, steps towards the development of a practical set of water-related indicators have been developed for the assessment of the six targets and associated indicators for SDG6.

There are a wide range of IWRM indicators used in a range of monitoring frameworks, however the assessment of these frameworks yielded just 66 indicators that correlated with the SDG Targets. These indicators were then be used to develop a successful framework, which when assessed held no interdependencies between the indicators. However, due to data availability, the framework included many indicators for which there is no data available in non-EU countries. In the future further development of indicators applicable for non-EU countries is required. It was noted that during the development of this framework, more indicator data became available, and therefore the framework needs to be routinely updated to incorporate the possibility more ideal indicators.

The use of targets results in the problem of the indicator being region or development level specific. Potentially using future scenarios could allow a selection of appropriate and achievable targets are consistent with one future scenario, but also apply to multiple countries. However, the developed framework currently represents the diversity within the monitored countries, except for those areas with high levels of water management (such as nutrient recovery). Finally, as the framework was representative of the nation it was monitoring, it is a useful addition to water management for progression towards the SDGs.

I conclude that the SDG6 indicators provide a useful framework to communicate progress on the water-related challenges with policy makers, but that the framework needs to be extended with scientifically sound, quantitative policy targets and additional indicators to become really operational in the science-policy interface, as demonstrated in the present thesis.

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8. ANNEXES

ANNEX 1

Assessment method

For each indicator, the assessment method is given below.

Category 1. Water Stress

Indicator 1: Water Scarcity

Principal: If a nations extraction of water is greater than 20% of their water resource it is deemed to be unsustainable. The Water Exploitation Index, developed by Eurostat measures how sustainable a nations water extraction is. The indicator presents i) the annual total fresh water abstraction in a country as a percentage of its long-term annual average (LTAA) available water from renewable fresh water resources; ii) the annual groundwater abstraction as a percentage of the country's long-term annual average groundwater available for abstraction; and iii) the annual surface water abstraction as a percentage of the country's long-term annual average surface water resources available for abstraction. The latter is calculated as the total fresh water resources (external inflow plus precipitation less evapotranspiration) less groundwater available for abstraction. The warning threshold of 20% for this indicator distinguishes a non-stressed from a water scarce region, with severe scarcity occurring where the WEI exceeds 40%. According to Eurostat the indicator has several limitations.

This index has been used in calculating indicator 1.

How to Calculate:

$$\boldsymbol{Indicator\ 1 = 10 - \frac{Water\ Exploitation\ Index}{10}}$$

If the Water Exploitation Index gives a low score, then the Indicator 1 value is a high as the nation is achieving the goal of sustainable water use.

Example: the water exploitation index (fresh surface and groundwater) for the Netherlands is 10.3.

$$\text{Indicator 1} = 10\text{- } (10.3/10) = 8.97$$

Where to get the data

https://ec.europa.eu/eurostat/web/products-datasets/-/t2020_rd220

Accessed 28-03-2019

Indicator 2: Flood vulnerability

Principal:

Climate scenarios suggest that there is a risk or increased flooding in Europe in the next century This is due to increased intensity in the rainfall events, with longer dry periods(Dankers & Feyen, 2008). For this reason, vulnerability to flooding is included as a water stress. Flood vulnerability is measured from the susceptibility to floods over 26 years, between 1985 and 2011. This uses data based on flood occurrence so that countries that have invested in flood defence would have a lower vulnerability score due to fewer floods occurring. The goal is to have a flood vulnerability score of 9 for each nation.

How to Calculate

The Water Risk Atlas created by Aquaduct is used to identify flood vulnerable areas. The five colours on the map were each given a score between one and nine, where one is the highest level of flood risk and nine has the lowest level of flood risk. For those countries which have more than one colour we can calculate the weighted score.

Flood vulnerability Scores

Risk Category	Colour Grade	Score
Extremely high risk	Dark Red	1
High risk	Red	3
Medium to high risk	Orange	5
Low to medium risk	Yellow	7
Low Risk	Cream	9

Example

Portugal lies within the orange for 80% of the country, and in the yellow for 20% in the north of the country. Thus, the score for Portugal becomes: 5*0.8 + 7*0.2 = 5.4

Therefore the overall score for Portugal is rounded to 5.

Data source
https://www.wri.org/applications/maps/aqueduct-atlas/#x=34.19&y=45.27&s=ws!20!28!c&t=waterrisk&w=def&g=0&i=BWS-16!WSV-4!SV-2!HFO-4!DRO-4!STOR-8!GW-8!WRI-4!ECOS-2!MC-4!WCG-8!ECOV-2!&tr=ind-1!prj-1&l=4&b=terrain&m=group&init=y
and go to the explore global water risk map, and the flood occurrence map.

Indicator 3: Transboundary cooperation

Principal: Many river basins, groundwater bodies and lakes are located at national borders or cros national borders. In order to successfully manage the water supply, there must be transboundary agreements in place(Orme et al., 2015). The indicator measures the presence of key international principles (Legal frameworks) for the transboundary basin. This indicator is taken from the Transboundary Water Assessment Programme (TWAP) undertaken by UNEP. The TWAP Project has river level indicators, one of which is the transboundary legal frameworks available for each river basin. This is scored on a basin scale, as well as a score proportional to a countries land area within the basin. The proportional score is referred to as the Basin Country Unit (BCU) and has been used for this indicator. The goal for each BCU is to have good legal agreements in place, which would give an indicator score of 10.

How to Calculate

BCU score = 0-1 where 1 is high risk and 0 is low risk. If a country has multiple transboundary rivers, the arithmetic mean of the final score has been taken.

X = Mean of the legal framework indicator score

$$\mathbf{Indicator\ 3 = 10 - (X * 10)}$$

Example:

Go to the TWAP website, select the legal framework indicators. Download the legal framework data and use the normalized basin country unit scores. For example in the Netherlands, the BCU score for the Scheldt is 0.86 and for the Rhine is 0. The average BCU score is taken.

Relative Risk Category	Basin Country Unit Code	Country	River Basin	Area [000' km2]	Population [000']	Population-Area Weight	Score for BCU	Score for BCU (Normalized)	
4	SHLD_NLD	Netherland	Schelde	0	4	0.00	1.00	0.86	
1	RHIN_NLD	Netherland	Rhine	4	3418	0.05	7.00	0.00	
								0.428571	5.714285

$$\frac{0.86+0.00}{2} = 0.43 = \mathrm{X}$$

$$\text{Indicator 3} = 10 - (0.43 * 10) = 5.71 \text{ or } 5.7$$

Data Source

http://twap-rivers.org/indicators/

Indicator 4: Tertiary Education Attainment

Principle: Attainment of education at a tertiary level yields highly educated professionals that are necessary in the creation or adoption of new technologies, fundamental for growth (Brunello et al., 2007) Without educated capital, the country would lack the skills required to cope with future challenges. A European target is for 40% of 30-34year olds to have tertiary education(European Comission, 2017)

How to Calculate:

A = % 25-64 year olds that have attained tertiary education

B = The lowest global tertiary education attainment, 2.29% (value of Eritrea)

40 has been taken as the maximum value so that the indicator score shows progression towards achieving the above goal.

$$\textbf{Indicator 4} = \frac{\mathbf{A - B}}{\mathbf{40 - \mathit{B}}} * \mathbf{10}$$

Example: For the Czech Republic, the value of A is 26.1.

$$\text{Indicator 4} = \frac{26.1 - 2.29}{40 - 26.1} * 10 = 6.3$$

Date: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=edat_lfse_03&lang=eng

Category 2. Water Quality

The following Water Quality indicators are included to monitor the chemical, ecological surface water status and the chemical status of groundwater. Water sources can suffer from point and non-point source pollution which can lead to a degradation of ecosystem services and biodiversity loss (Bakker et al., 2012).

Indicator 5: Surface water Quality

Principal: The chemical quality of the surface water used as a drinking water source. A high score donates high water quality. The goal for each country is to ensure that every water source achieves good status or higher.

How to Calculate

$$\textbf{Indicator 5} = \frac{\textbf{surface water sources with a 'good' status}}{\textbf{total surface water sources assessed}} * \textbf{10}$$

Example:

The total surface water bodies in Spain (rivers and lakes only) that reached 'good' chemical status according to the wise water framework was 4225 out of 4716.

$$\text{Indicator } 5 = \frac{4225}{4716} * 10 = 8.95$$

Data https://www.eea.europa.eu/data-and-maps/dashboards/wise-wfd

Last accessed 08-April 2019

Indicator 6: Ground water Quality

Principal: Measure of relative groundwater chemical quality. A lower Indicator score is given for poorer quality. The goal is for all groundwater sources to achieve good status.

How to Calculate

$$\textbf{Indicator 6} = \frac{\textbf{groundwater sources with a 'good' status}}{\textbf{total surface water sources assessed}} * \textbf{10}$$

Data: Groundwater Bodies Chemical status (GWB Chemical Status):

https://www.eea.europa.eu/data-and-maps/dashboards/wise-wfd

Last accessed 16th-January 2019

Example:

The total number of Swedish Groundwater bodies tested for their chemical quality was 40438. Of these 37955 achieved good chemical status.

$$\text{Indicator } 6 = \frac{\textbf{37955}}{\textbf{40438}} * \textbf{10} = \textbf{9.4}$$

Giving Indicator 5 for Sweden as 9.4.

Indicator 7: Ecological Water Quality

Principal: The quality of the surface water used as a drinking water source. A high score donates high water quality. The goal is for each surface water source to achieve ‘good’ ecological status.

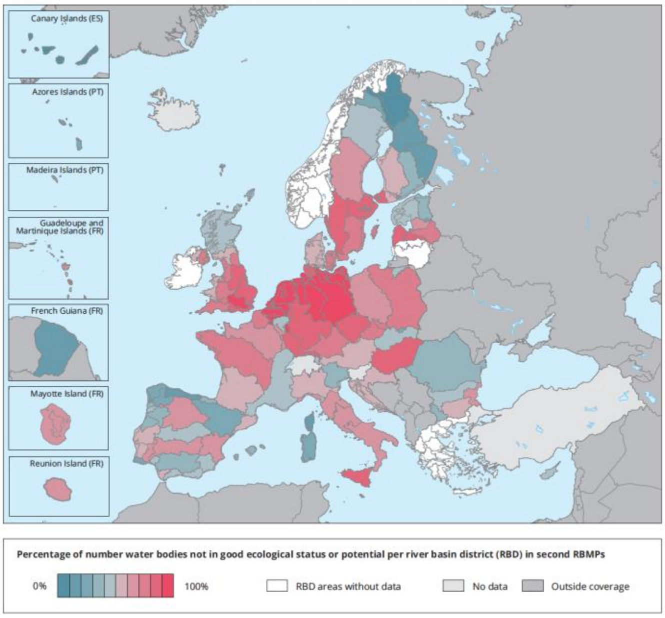
How to Calculate

$$\textbf{Indicator 7} = \frac{\textbf{surface water sources with a 'good/high' ecological status}}{\textbf{total surface water sources assessed}} * \textbf{10}$$

Example: For the Spain, a total 2584 lakes and rivers gained a good or high Ecological status, of a total of 4716 surface water bodies.

$$\text{Indicator 7} = \frac{\mathbf{2584}}{\mathbf{4716}} * \mathbf{10} = \mathbf{5.5}$$

Map 2.1 Percentage of water bodies in Europe's RBDs that are not in good ecological status/potential: second RBMPs



Where to get the data

https://www.eea.europa.eu/data-and-maps/figures/proportion-of-classified-surface-water-5 last accessed 16th January 2019. Go to Surface Water Bodies (SWB) ecological status

Category 3. Access basic water services

Indicator 8: Drinking Water Quality

Principal: The quality of the water supply gives an indication of the capacity of the system for filtration and transport(Hoekstra et al., 2018).This is taken from the level of compliance with drinking water regulations, for EU countries this is the Drinking Water Directive. The goal is for the compliance value to be 100.

How to Calculate

$$\textbf{Indicator 8} = \frac{\textbf{Level of compliance idicator value}}{\textbf{10}}$$

Example: the compliance rate for Poland has a value of 99.8, giving a value of 9.98 for indicator 8.

Where to get the data

Use Table 1 on pages 12/13:

http://ec.europa.eu/environment/water/water-drink/pdf/reports/EN.pdf

Indicator 9: Population connected to a drinking water supply

Principal: This represents the percentage of the population that receives a piped drinking water supply rather than reliant on a local spring source or an alternative source. This shows the development of water infrastructure present(Hoekstra et al., 2018). A lower indicator score is given when the percentage is low. The goal is for 100% of the population to receive a piped source of drinking water.

How to Calculate

A = Population connected to a piped drinking water supply

B = Total population

$$\textbf{Indicator 9} = \frac{\textbf{A}}{\textbf{B}} * \textbf{10}$$

Example: In Poland, 91.8% of the population is connected to a drinking water supply. This gives an indicator value of 9.2.

Where to get the data

https://washdata.org/data

Indicator 10: Percentage of the population connected to improved sanitation

Principal: A measure of the percentage of the population covered by wastewater collection and treatment. Improved sanitation facilities mean that excreta has been separated away from human, this does not distinguish between separation techniques. Separation can include via a sewerage network, in-situ treatment and disposal as well as onsite storage with removal for treatment(JMP, 2017). A lower Indicator score is given where the percentage is lower. The goal is for 100% of the population to have improved sanitation.

How to Calculate

A = The percentage of the population connected to improved sanitation.

$$\textbf{Indicator 10} = \frac{\mathbf{A}}{\mathbf{10}}$$

Example: In Sweden, 92 % of the population is connected to improved sanitation, this gives an indicator value of 9.2.

Where to get the data

https://washdata.org/data.

Use household data, go the world file. Use the most recent data (e.g. 2015). Safely managed sanitation at the national level.

Indicator 11: Water affordability

Principal: Within Europe, water is readily available, usually piped directly into the home. However, some individuals face financial difficulties in being able to afford this water. If water costs more than 3% of the individuals income, then they are said to be water poor(García-Valiñas et al., 2010). The goal is to ensure that whilst water is used sustainably, it remains affordable with the pricing below 4% of the average income.

The data is taken from a 'households' average monthly water bill – where a household is assumed to be two adults and two children. The household bill is then divided by two to represent the two adults paying for the bill.

How to calculate

A: average household water bill per month

B: average income per month

0.3 is the conversion value to give an indicator score between 0-10.

$$\textbf{Indicator 11} = 10 - \left(\frac{A}{B} * \frac{1}{0.39} * 100\right)$$

Example: In Spain

A = 13.65(US $)

B = 2265 (US $)

$$\textbf{Indicator 11} = 10 - \left(\frac{13.65}{2265} * \frac{1}{0.39} * 100\right) = 8.5$$

Where to get the data

Water bill per month (USD): http://cdn.thejournal.ie/media/2016/09/tariffs-4.jpg last accessed 20th December 2018

Average monthly income (USD): https://www.worlddata.info/average-income.php last accessed 8 April 2019.

Category 4. Infrastructure

Indicator 12: Infrastructure investment

Principal: Investment into infrastructure is required for the infrastructure to be properly maintained and for new technologies to be implemented. The goal for infrastructure investment is 3.8% of national GDP(Santarsiero et al., 2016).

How to Calculate:

To calculate this, the most recent data on infrastructure investment is used. This is from 2010. The GDP of 2010 is then also used to measure the amount of investment relative to the GDP. In order to create a score from 0-10, this is then multiplied by a conversion factor of 263.

A= 2010 infrastructure investment

B = 2010 GDP

$$\textbf{Indicator 12} = \frac{A}{B} * 263$$

Example

For Poland, A = 722453066 and B= 360344273490, giving the infrastructure investment as 2% of GDP and an indicator score of 5.28.

$$= \frac{722453066}{360344273490} * 263 = 5.28$$

Where to get the data

Transport infrastructure investment and maintenance spending (OECD):

https://stats.oecd.org/Index.aspx?DataSetCode=ITF_INV-MTN_DATA

Infrastructure investment is found in euros and converted to US$ using the average 2010 exchange rate.

World Bank GDP (current USD): https://data.worldbank.org/indicator/ny.gdp.mktp.cd

Indicator 13: Water leakage

Principal: Leakages from the water network effects water use efficiency as well as water quality(EEA, 2001). Target 6.4 of the SDGs is to increase water-use efficiency, therefore the goal is for no water to be lost due to leakage.

How to Calculate

Leakage rates of 50% are taken to be the maximum value and would thus score 0.

$$\textbf{Indicator 13} = 10 - \frac{\textbf{percentage water lost}}{10} * 2$$

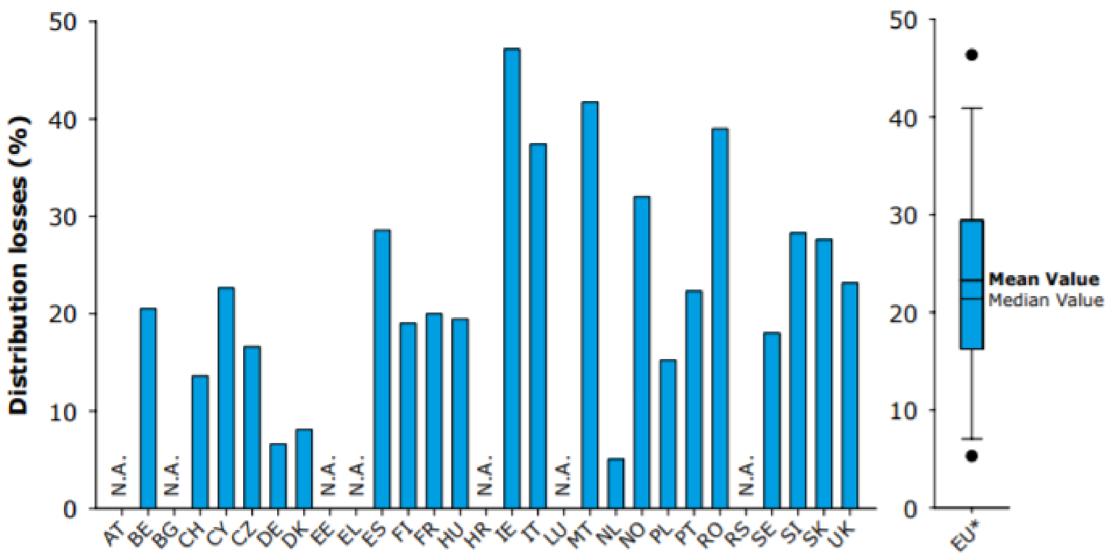
Example: In Sweden, distribution losses account for 18% of water lost in the system.

$$\textbf{Indicator 13} = 10 - \left(\frac{18}{10} * 2\right) = 6.4$$

Where to get the data

Percent water lost per kilometre of network:

https://www.danva.dk/media/3645/eureau_water_in_figures.pdf (EU) *illustrated in Figure 19 of the report, shown in the graph below.*



Category 5. Waste water treatment

Indicator 14: Secondary Waste Water Treatment(WWT)

Principal: Measure of the population connected to secondary wastewater treatment plants. Primary treatment treats the physical water contamination, whereas secondary water treatment also treats the biological and organic contamination(de Moel et al., 2006). The goal is for all nations to have 100% Secondary WWT.

How to Calculate

A = Percentage of secondary WWT

B = Percentage of tertiary WWT

$$\mathbf{Indicator\ 14} = \frac{\mathbf{A + B}}{\mathbf{10}}$$

Example: In Sweden the percentage of secondary WWT is 2.5%, the percentage of tertiary WWT is 92.9%. Therefore, the amount of waste that is treated to at least a secondary level is 95.4%.

$$\mathbf{Indicator\ 14} = \frac{\mathbf{2.5 + 92.9}}{\mathbf{10}} = \mathbf{9.54}$$

Definition of secondary WWT: Definition secondary WWT: Secondary treatment: process generally involving biological treatment with a secondary settlement or other process, with a BOD removal of at least 70% and a COD removal of at least 75% (OECD, 2013).

Where to get the data

https://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment/urban-waste-water-treatment-assessment-4 Click on the Table and data are shown for secondary and tertiary treatment

Indicator 15: Percentage of tertiary Waste Water Treatment

Principal: Measure of the population connected to tertiary wastewater treatment plants. Tertiary wastewater treatment is the final stage in the treatment process and removes inorganic compounds, carbonaceous matter and additional solids before the water is released into surface water. Reuse of water reduces required water extraction(Cirelli & Salgot, 2001). The goal is for all nations to have the highest level of wastewater treatment, 100% being tertiary treatment.

How to Calculate

$$\mathbf{Indicator\ 15} = \frac{\mathbf{Percentage\ of\ tertiary\ treatment}}{\mathbf{10}}$$

Example

As seen above, 92.9% of Sweden's water treatment is to a tertiary level.

$$\mathbf{Indicator\ 15} = \frac{\mathbf{92.9}}{\mathbf{10}} = \mathbf{9.3}$$

Definition of tertiary: Tertiary treatment: treatment of nitrogen and/or phosphorous and/or any other pollutant affecting the quality or a specific use of water (microbiological pollution, colour, etc.). (OECD, 2013)

Where to get the data

https://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment/urban-waste-water-treatment-assessment-4 Click on the Table and data are shown for secondary and tertiary treatment

Indicator 16: Nutrient Recovery (%)

Principle: Nutrients recovered from sewage sludge by use as agricultural manure or via composting. In order to fully implement the circular economy all nutrients should be recovered from wastewater(Jurgilevich et al., 2016).

How to calculate

A. Dry weight of sludge produced in wastewater treatment plants serving the city
B. Dry weight of sludge going to landfill
C. Dry weight of sludge thermally processed
D. Dry weight of sludge disposed in agriculture

E. Dry weight of sludge disposed by composting

F. Dry weight of sludge disposed by other means
(As a check, A should = B + C + D +E+F)

$$\textbf{Indicator 16} = \frac{D+E}{A} * \frac{\%\ \text{secondary WWT coverage}}{100} * 10$$

To measure the full potential of nutrient and energy recovery from wastewater by using wastewater abstracted sewage sludge, secondary WWT is incorporated in the calculation and not primary WWT. In this way the concept of urban metabolism is better represented. Secondary WWT produces more sewage sludge than Primary WWT.

Example: German sewage sludge is used both for agriculture and in compost.

With 491 thousand tonnes in Agriculture and 264 thousand tonnes in compost and a secondary WWT of 94.4%.

$$\frac{491 + 264}{1795} \times \frac{95.4}{100} \times 10 = 4.01$$

This gives the Indicator 16 value of 4.0 for Germany.

Where to find the data

https://data.europa.eu/euodp/data/dataset/hzWkcfKt5mxEaFijeoA

Go to visualize Table and select the data for the calculations

Indicator 17: Wastewater to energy

Principle: Energy can be gained from sewage waste by incineration(van der Hoek et al., 2017). To achieve the goal of the circular economy, energy needs to be gained from wastewater.

How to calculate

A. Dry weight of sludge produced in wastewater treatment plants serving the city
B. Dry weight of sludge going to landfill
C. Dry weight of sludge thermally processed
D. Dry weight of sludge disposed in agriculture

E. Dry weight of sludge disposed by composting

F. Dry weight of sludge disposed by other means
(As a check, A should = B + C + D +E+F)

$$\textbf{Indicator 17} = \frac{\boldsymbol{C}}{\boldsymbol{A}} * \frac{\%\ \textbf{secondary WWT coverage}}{100} * \textbf{10}$$

Example: The Netherlands incinerates 6608 thousand tonnes of waste, of a total of 9497 thousand tonnes.

$$\frac{6608}{9497} \times \frac{99.4}{100} \times 10 = 6.9$$

This gives a value of 6.9 for indicator 16 for the Netherlands.

Where to find the data

https://data.europa.eu/euodp/data/dataset/hzWkcfKt5mxEaFijeoA

Go to visualize Table and select the data for the calculations

Category 6. Solid Waste treatment

Indicator 18: Municipal Solid waste (MSW) generated

Principal: Solid waste collected by the municipality, not including large industrial waste. Untreated municipal waste can result in pollution and the release of toxins into the environment, there is a link between the quantity of waste produced and the presence of garbage in water bodies(Hoekstra et al., 2018). The goal is to reduce the solid waste produced to 10% of 2010 levels by 2010 based on the Spanish waste prevention objectives(EEA, 2014).

How to Calculate

$$\textbf{Indicator 18} = \frac{\textbf{percent total waste generated}}{\textbf{10}}$$

Example: In the United Kingdom, 100% of solid waste is collected, giving an indicator value of 10.

Where to get the data

http://data.un.org/Data.aspx?q=municipal+waste&d=ENV&f=variableID%3a1814

Indicator 19: Municipal Solid Waste recycled

Rationale: Percentage of solid waste that is recycled or composted. To ensure that there is a reduced loss of raw materials, waste should be recycled. The EU recycling target for 2030 is that 65% of municipal waste is recycled.

How to Calculate

A = Percent of municipal solid waste that is recycled

$$\textbf{Indicator 19} = \frac{\boldsymbol{A}}{\mathbf{65}} \times \mathbf{10}$$

Example: In Greece, 16.4% of solid waste is recycled, giving an indicator value of 2.5.

$$\textbf{Indicator 19} = \frac{\mathbf{16.4}}{\mathbf{65}} \times \mathbf{10} = \mathbf{2.52}$$

Data: https://stats.oecd.org/ Go to Environment and click on waste and then to municipal waste.

Indicator 20: Solid waste energy recovery

Principal: Percentage of solid waste that is incinerated with energy recovery. (Environmental Service Association, 2018)In the ideal scenario, 100% of energy available for recovery should be recovered.

How to calculate

This indicator represents the percentage of the total collected municipal waste that incinerated with energy recovery (techniques). However, when solid waste is recycled or composted, it is not possible to also use it for incineration with energy recovery, while both practices are sustainable. Therefore the % solid waste that is recycled or composted is subtracted from the total (100%) of collected municipal waste to obtain the potential percentage of solid waste that can be incinerated with energy recovery (in numerator). Thus this indicator is calculated as shown below.

A: municipal solid waste incinerated with energy recovery

B: municipal solid waste recycled

C: municipal solid waste generated

$$\textbf{Indicator 20} = \frac{\mathrm{A}}{\mathrm{C} - \mathrm{B}} \times 10$$

Example: The municipal solid waste incinerated with energy recovery was 10863 thousand tonnes in Poland, 2,867 thousand tonnes of this was recycled and 1318 thousand tonnes was incinerated with energy recovery.

$$\textbf{Indicator 20} = \frac{1318}{(10863-2867)} \times 10 = 1.7$$

Giving 1.7 as the indicator 20 value for Poland.

Where to get the data

https://stats.oecd.org/ last accessed 9th January 2019. Go to Environment and click on waste and then to municipal waste.

Category 7. Climate adaptation

Indicator 21: CO_2 emissions

Principal: CO2 emissions are a greenhouse gas(GHG) and so increase the global warming effect. Maintaining high GHG emissions will have a negative impact on the climate and resources(van Vuuren et al., 2011). Without monitoring CO2 emissions alternative freshwater sources (such as decarbonisation) increase index scores with their negative environmental impact being unaccounted for(Dawoud & Al Mulla, 2012). Reducing greenhouse gas emissions by 40%(from 1990 levels) is a key target in the 2030 climate and energy framework(European Council, 2014).

How to calculate

A= 1990 CO2 emissions per capita

B= 2014 CO2 emissions per capita

The target of 40% reduction is used.

$$\text{Indicator 21} = \frac{A-B}{A\times 0.4}*10$$

Example:

In the example of Belgium. The CO2 emissions per capita in 1990 were 10.64 metric tonnes per capita and had decreased to 8.33 metric tonnes per capita in 2014.

$$\text{Indicator 21} = \frac{10.64-8.33}{10.64\times 0.4}*10 = 5.43$$

Where to get the data

https://data.worldbank.org/indicator/EN.ATM.CO2E.PC

Indicator 22: Renewable energy share (%) of total final energy consumption

Principal: Increasing renewable energy sources is a way to mitigate climate change, and move away from a fossil resource based economy(Owusu & Asumadu-Sarkodie, 2016). A key target for the climate and energy framework 2030 for the EU is to have a share of 27% renewable energy for the countries energy provision (European Comission, 2016)(Article 3 of Directive 2008/98/EC) .

How to calculate

$$\textbf{Indicator 22}: \frac{\textbf{Renewable energy share (\%)}}{\textbf{27}} * \textbf{10}$$

Example:

Using the Netherlands as an example, in 2015 5.89% of the energy was from a renewable source. This gives an indicator score of 2.18.

$$\frac{\textbf{5.89 (\%)}}{\textbf{27}} * \textbf{10} = \textbf{2.18}$$

Where to get the data

http://databank.worldbank.org/data/reports.aspx?source=1261&series=2.1_SHARE.TOTAL.RE.IN.TFEC

Indicator 23: Notre Dame readiness index

Principal: Notre Dame Global Adaptation Initiative (ND-GAIN) measures overall readiness by considering three components – economic readiness, governance readiness and social readiness. Readiness measures a country's ability to leverage investments and convert them to adaptation actions. (Chen, 2015)The goal is to have a score of 1 in readiness.

How to calculate

The ND-GAIN score is given as a value between 0-100 for each country with high values showing more readiness to adapt to climate change impacts.

$$\textbf{Indicator 23} = \textbf{ND} - \textbf{GAIN Score} \times \textbf{10}$$

Example

Using Ireland as an example, the ND-GAIN readiness score is 0.640, giving an indicator score of 6.4.

$$\mathbf{0.640 \times 10 = 6.4}$$

Where to get the data

https://gain-new.crc.nd.edu/ranking/readiness

Indicator 24: Integrated Water Resources Management Implementation

Principal: There are many synergies between water management and the development of sanitation, agriculture and energy, however water targets for these industries are lacking in their respective goals. Including an IWRM indicator shows the degree to which an integrated approach is being used(Ait-Kadi, 2016)**.** The indicator measures the percentage of Integrated Water Resources Management (IWRM) in river basin management plans. The goal is for all basins to be managed using IWRM.

How to Calculate:

$$\text{Indicator 24} = \frac{\textit{IWRM implementation}}{10}$$

Example

Poland has 40% IWRM implementation, therefore the indicator value is 4.

Where to get the data

http://www.sdg.org/datasets/406e085811164632b16f701eecdbdefd_0

Click on data

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Annex 2

Complementary NBF indicators	Associated SDG goals
4. Tertiary Education	
Tertiary level education is important in developing new innovative techniques, in infrastructure and science. There is increased future vulnerability if there is a deficit in an educated population.	
8.Drinking water quality	
A good quality drinking water supply would reduce risk of water-related illness, working towards target 3.9.2 (reduce mortality attributed to unsafe WASH services)	
12.Infrastructure investment	
More monetary investment into infrastructure would suggest that maintenance to the water supply network would be carried out. It also suggests that improvements to the water supply network and technology could also be carried out.	
15.Tertiary WWT	
The tertiary wastewater treatment builds in the secondary wastewater treatment, but also shows that there is a higher level of water treatment occurring. This indicator therefore also can be linked with the progression towards improving health and well-being as well as ensuring that cities are more sustainable.	
13.Water leakage	
Water leakage can occur due to poor quality or old infrastructure and results in a loss of revenue for the supplier as well as a decreased distribution efficiency. Target 9.4 aims to upgrade infrastructure to make it more resource efficient. Monitoring the amount of water leakage would show progression towards this target.	
16. Nutrient recovery	
Nutrient recovery records the current amounts of nutrients recovered from the wastewater. The more nutrients recovered, the less the need for nutrients to be mined for fertiliser. Thus making the	

communities more sustainable (goal 11). Additionally this also overlaps with goal 12, in the sustainable management of resources(target 12.2).

17.Wastewater to Energy

Measuring the amount of wastewater sludge used for energy is another example of measuring progress towards the circular economy. Energy from wastewater could also indicate progress to goal 7 as target 7.2 is for renewable energy sources to increase within the global energy mix. Having a renewable resource from the wastewater also means that the community serviced will also be more sustainable and reliant (goal 11).

18. Solid waste generated

Generated waste can be used as a measure of the amount of waste produced, the less waste produced, the more sustainable and aware the population is. Less waste may also indicate that the surface water is likely to be of higher quality.

19. Solid waste recycled (%)

The recycled waste can be used to show progression towards goal 11, as recycling leads to reusing the resources. As recycling of solid waste is often carried out by the municipality, the indicator can also be linked with goal 13 as there is likely to be policies in place to support the recycling.

20.Solid waste to energy

As with the complementary indicator 16 above, energy from solid waste can indicate progression towards target 7.2 for more renewable energy sources as part of the global energy mix.

21. CO2 emissions per capita

Indicator 20 acts as a measurement of the current state of emissions. This can be used to show progress towards goal 13. Lower CO2 emissions show that policies to reduce greenhouse gas emissions may have been taken into effect.

22. Renewable energy % total

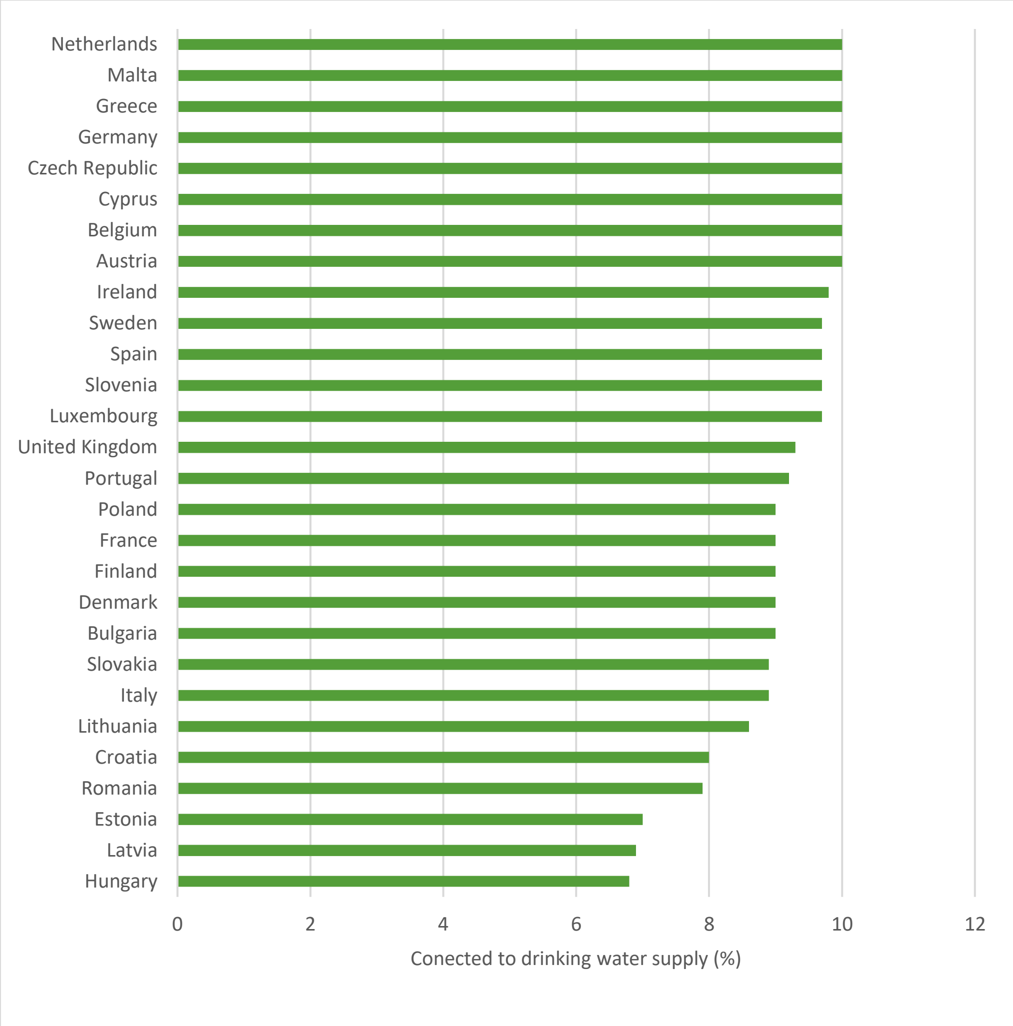
This indicator shows the current state of renewable energy use within the country. This makes the country more secure in terms of future supply and the risk of reducing fossil fuel resources. Renewable energy sources are also more sustainable, as well as producing less green-house gas emissions in production.

23. Notre Dame Readiness Index	
Indicator 22 measures the capacity of a country to use investments in adaptation actions. The more ready they are the more adaptable they are to future climate scenarios. As the readiness index measures governance readiness, it can also be used to show progression to goal 13.	

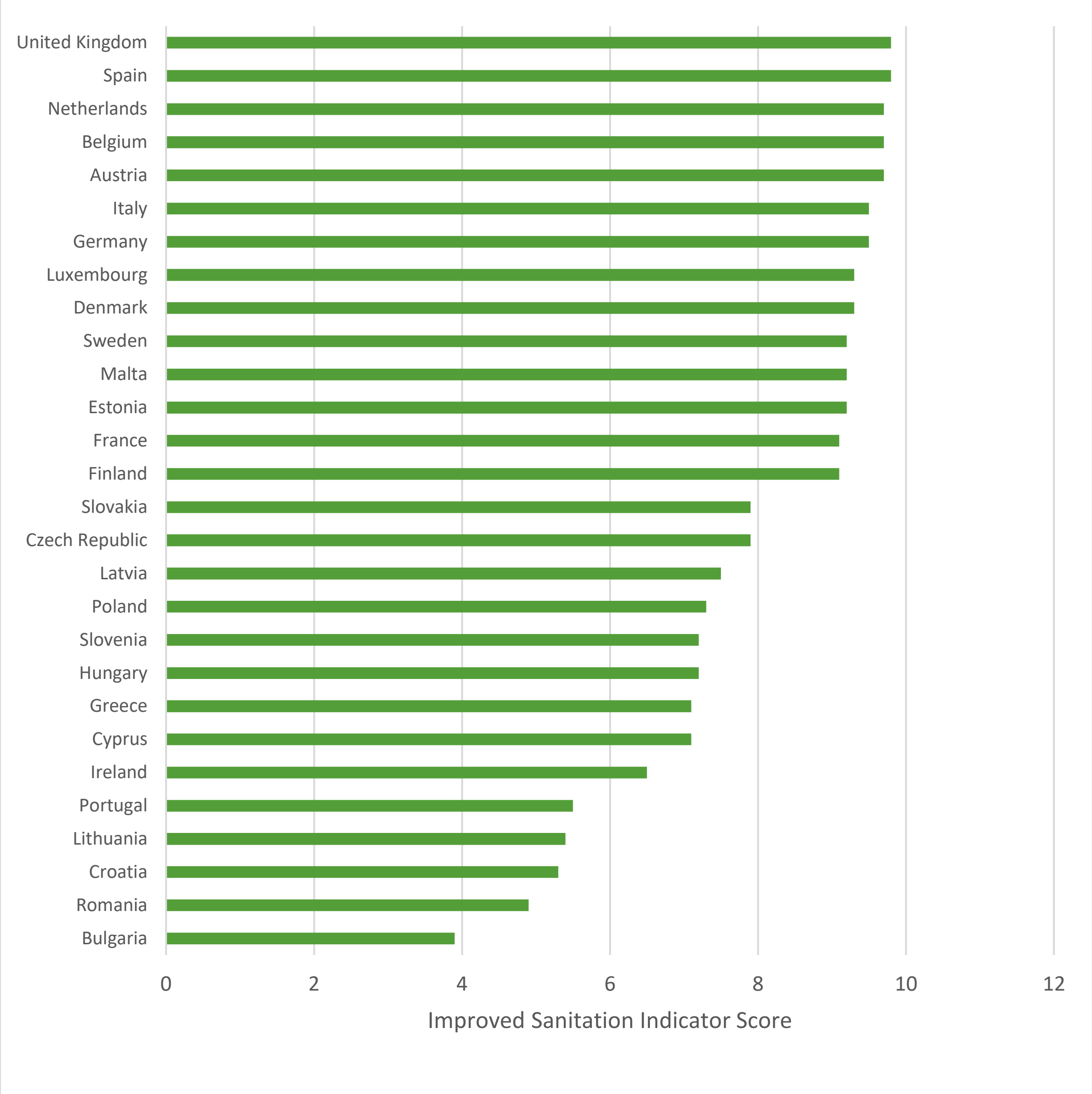
Annex 3

The first section of the results are graphs of the scores for the key indicators. The order of the indicators follows that of Table 4 and the order of the SDG 6 targets to which they relate.

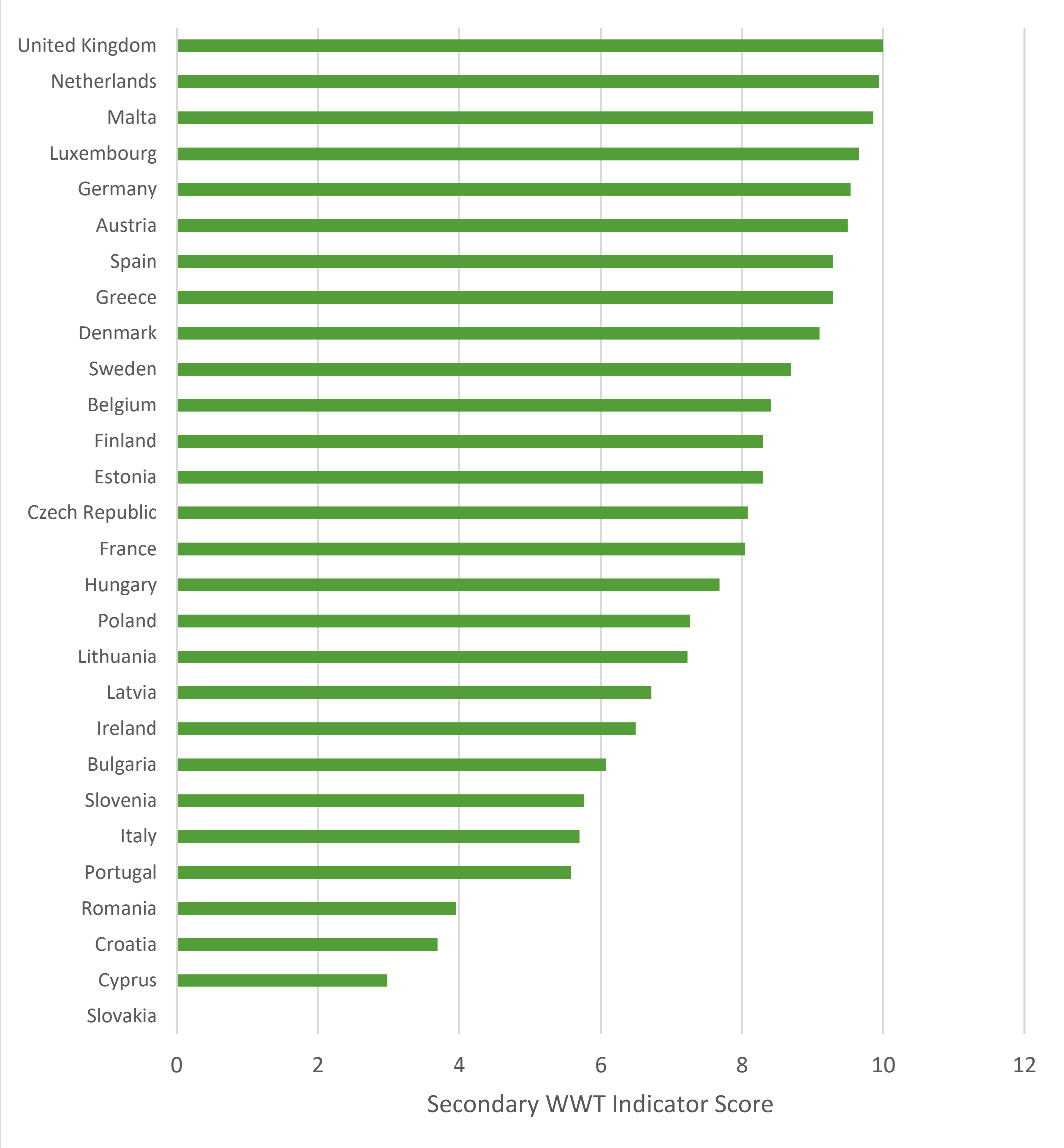
8. Connected to drinking water supply (%)



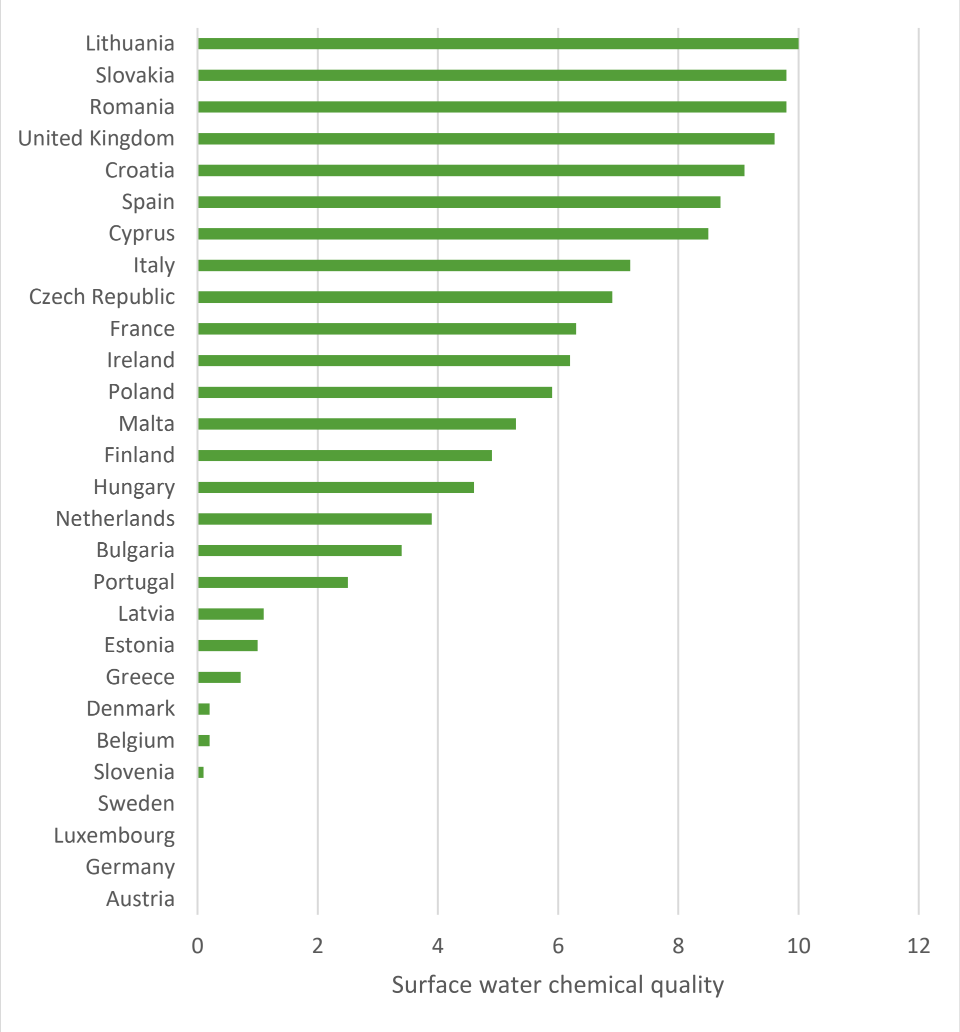
9.Connected to improved sanitation (%)



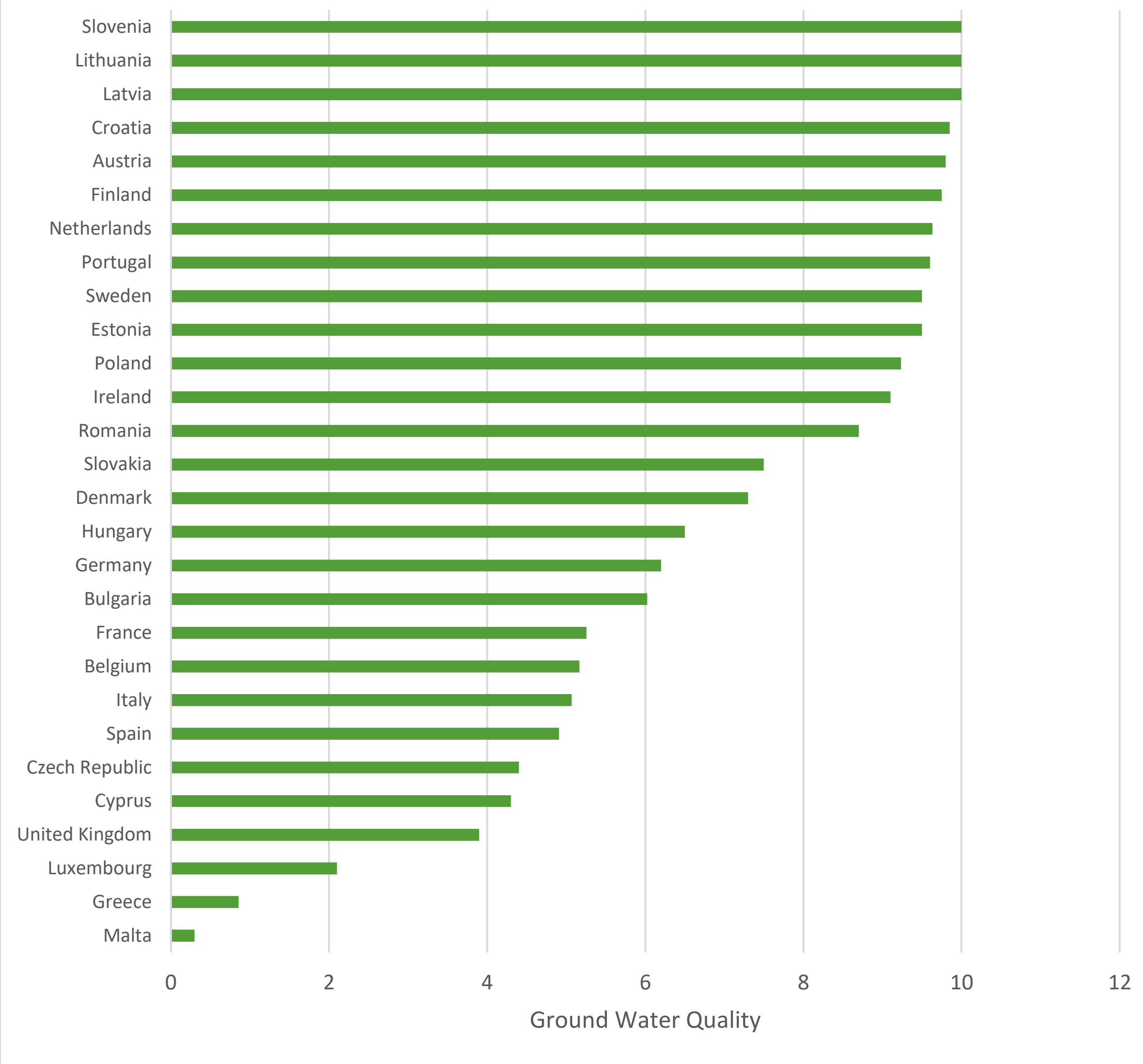
13.Secondary WWT



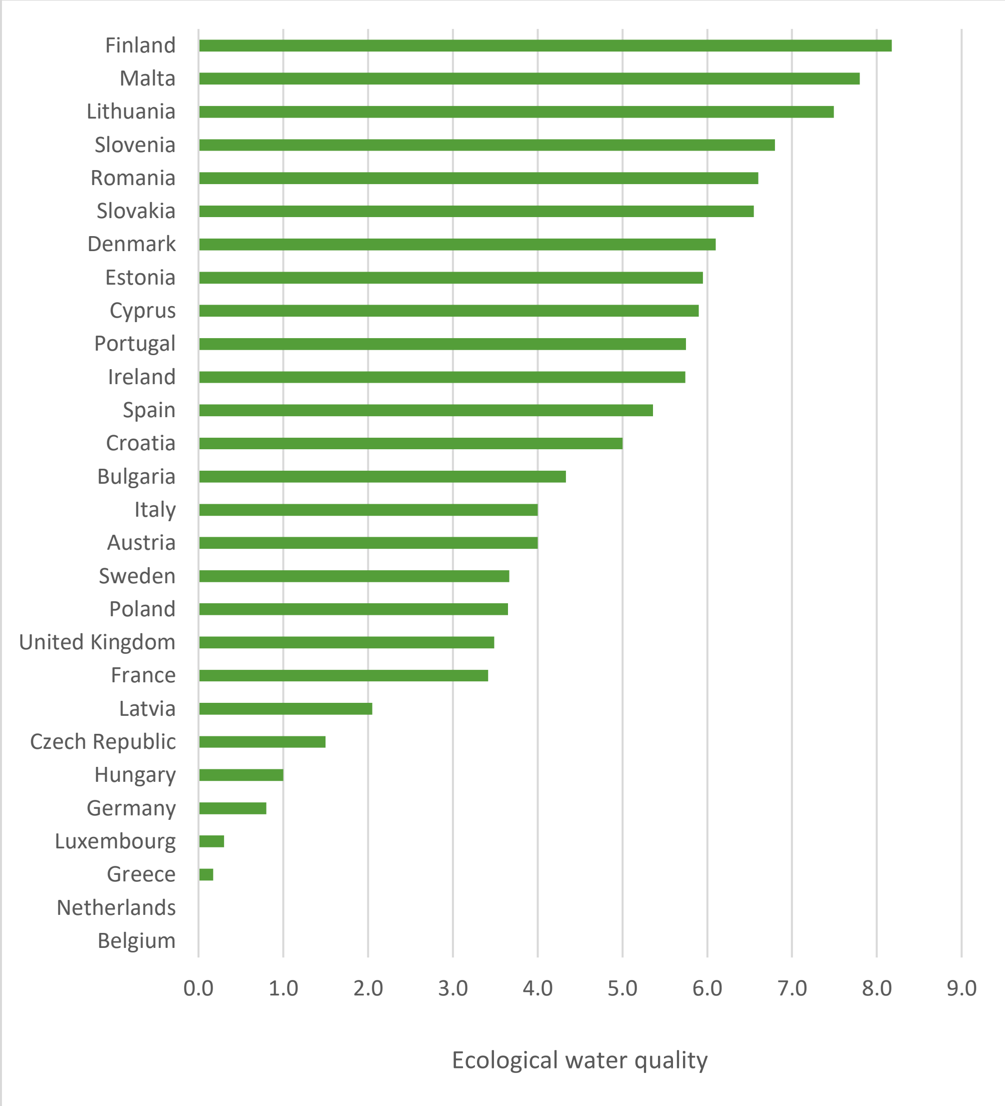
4.Surface water quality



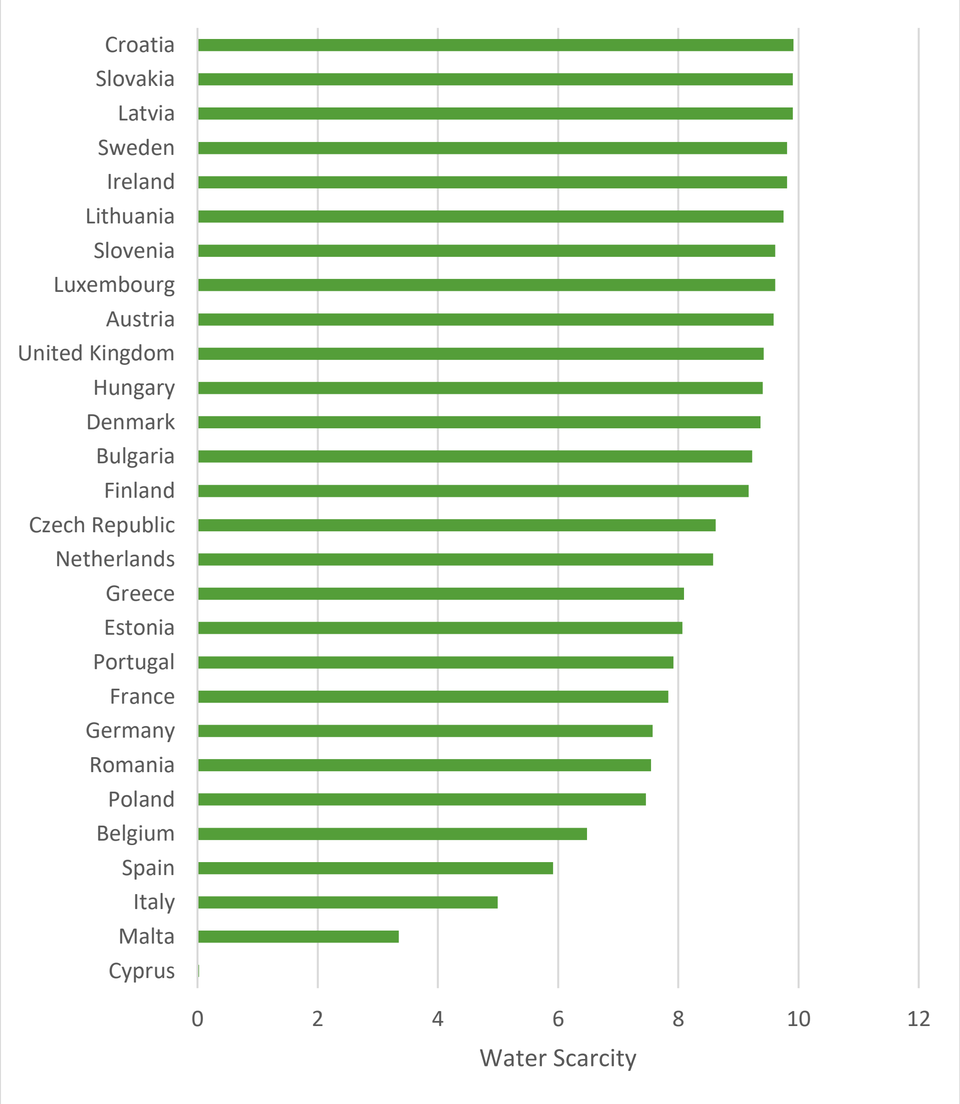
5.Groundwater quality



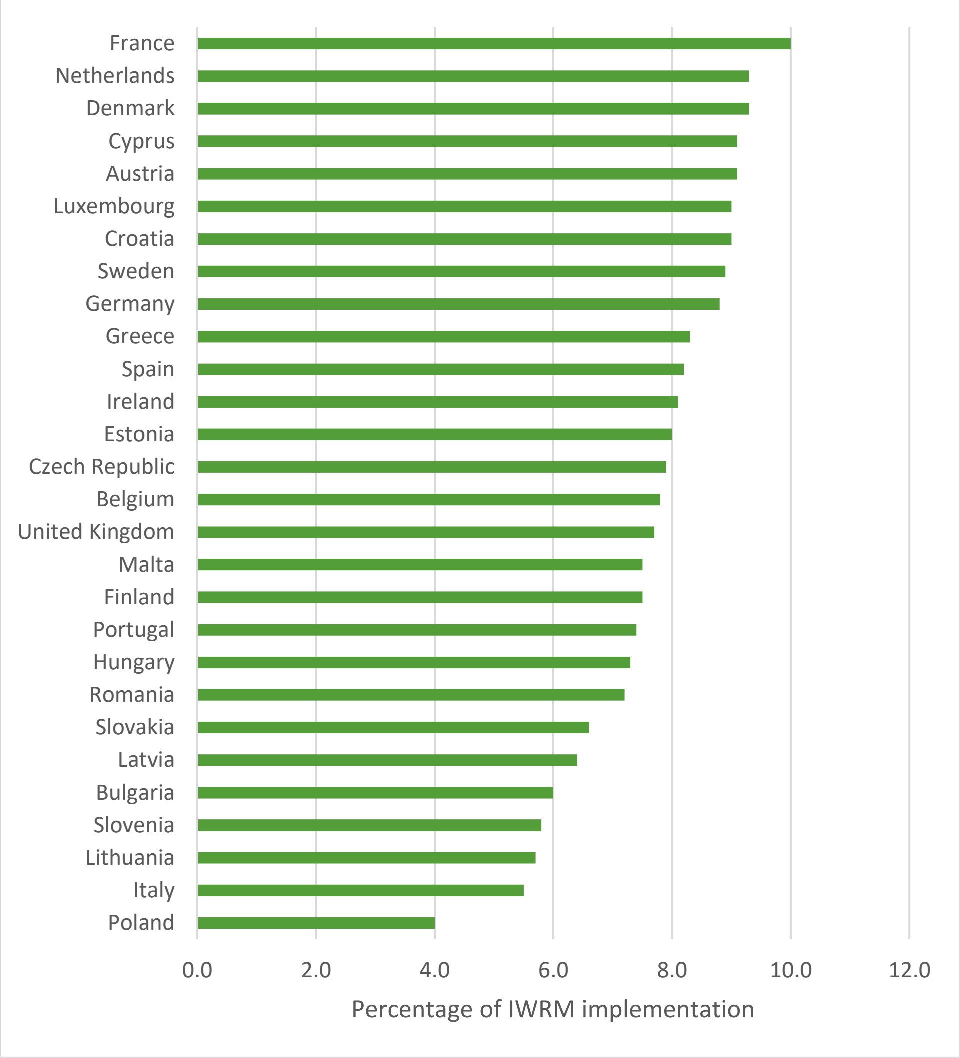
6.Ecological water quality



1. Water Scarcity

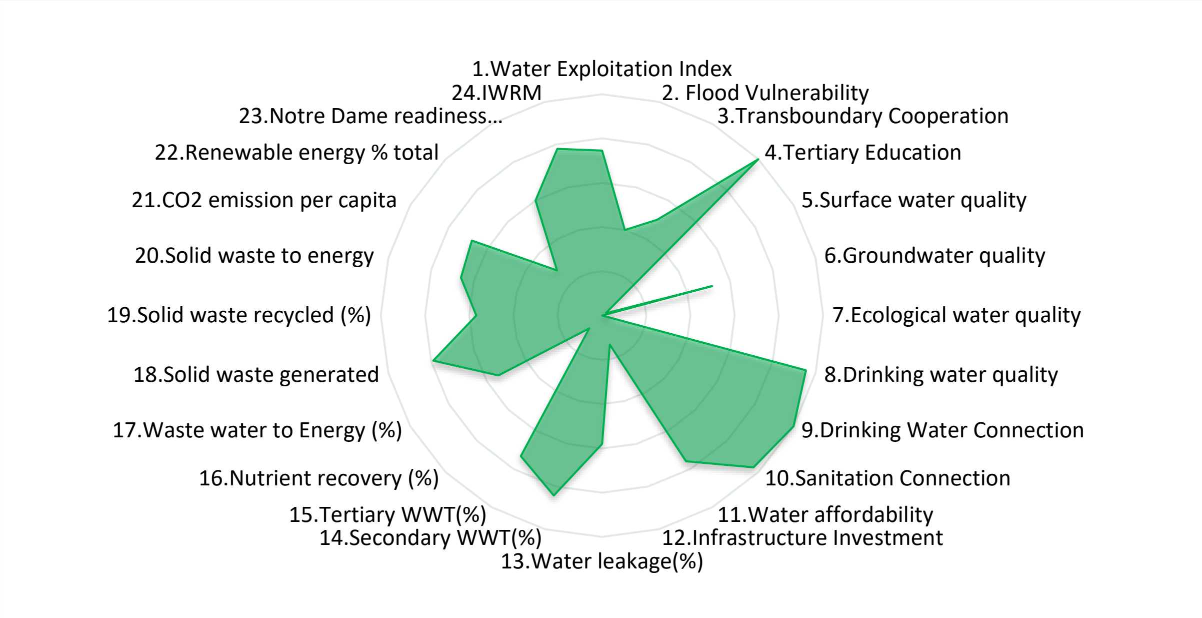


23.Percentage of implementation of IWRM

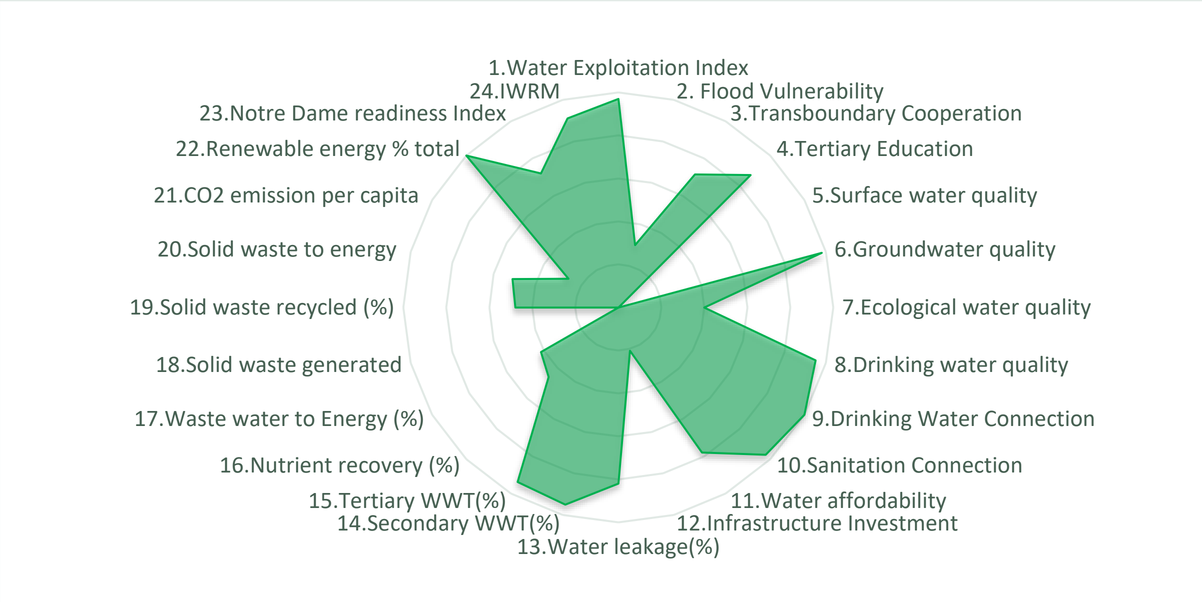


The following section gives the results for each country with a spider diagram.

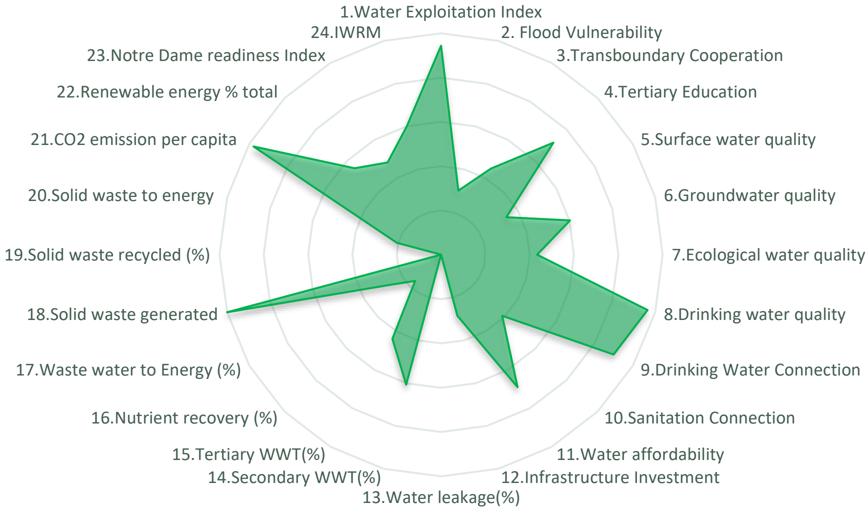
Austria



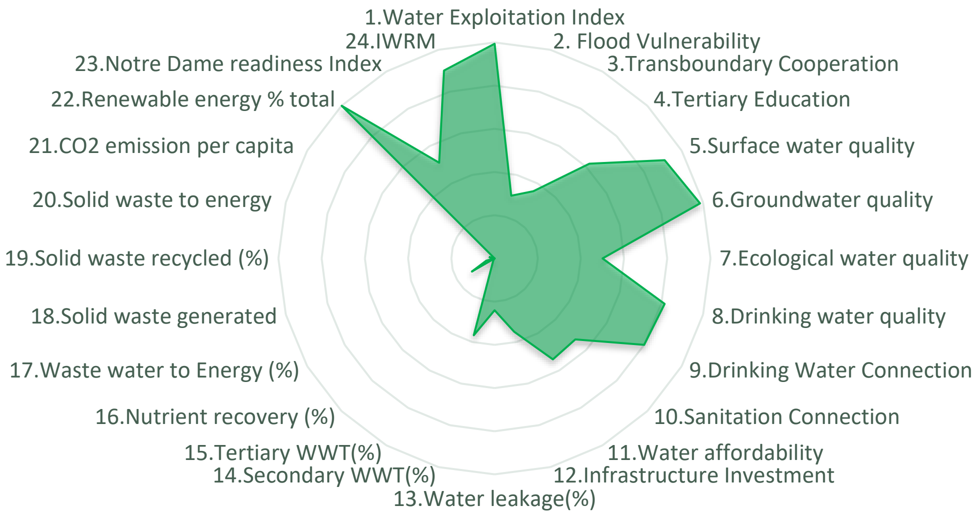
Belgium



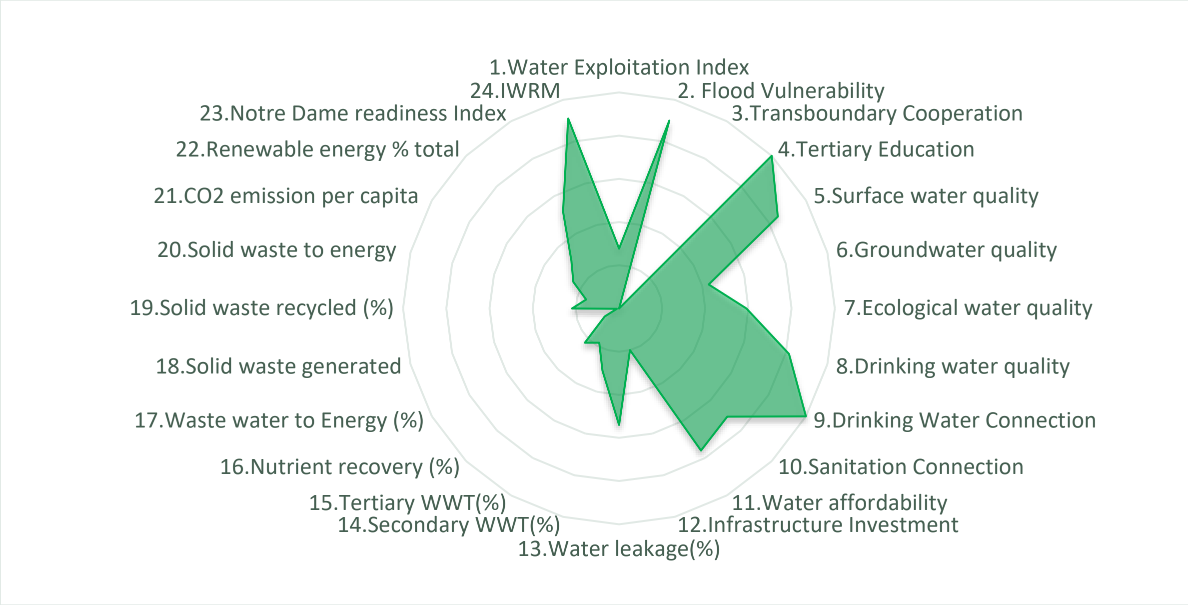
Bulgaria



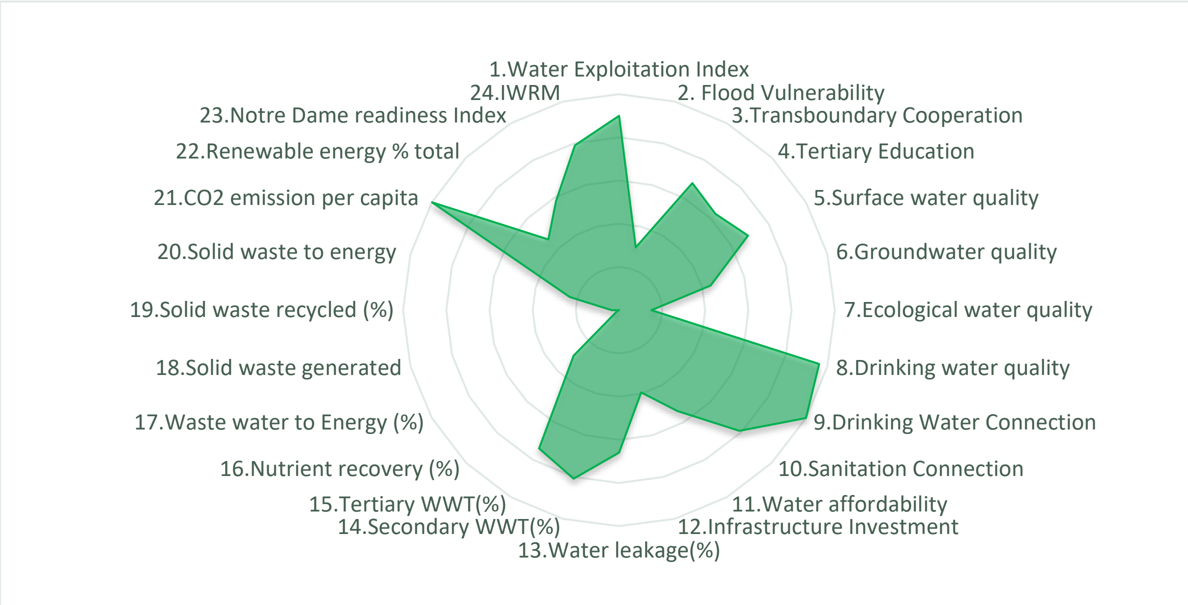
Croatia



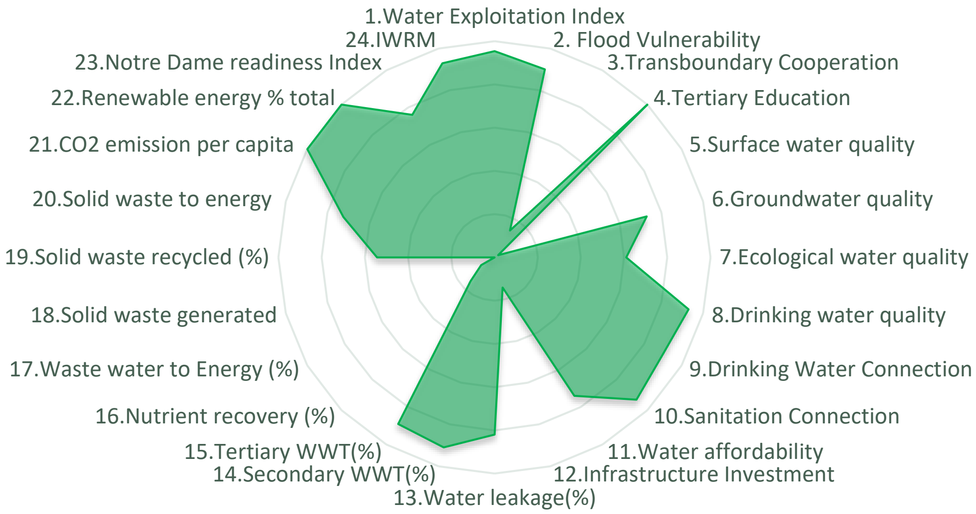
Cyprus



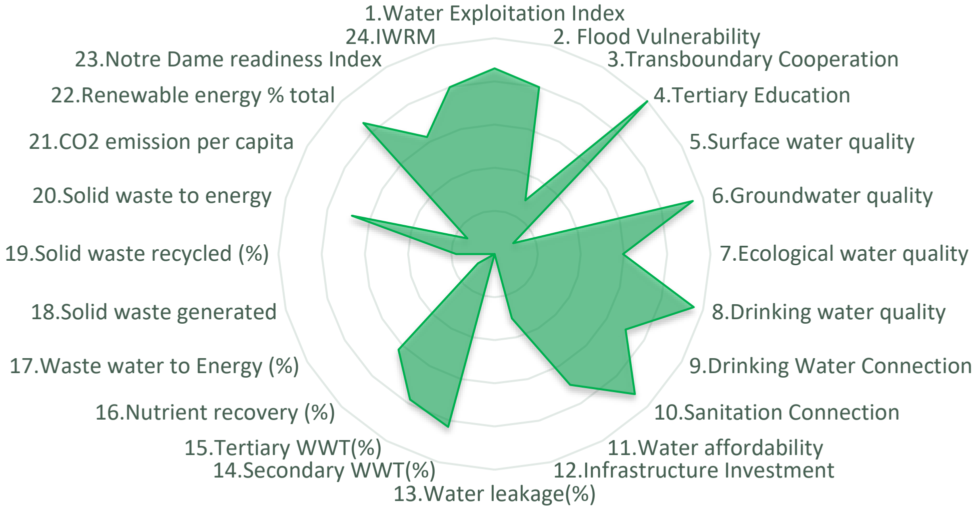
Czech Republic



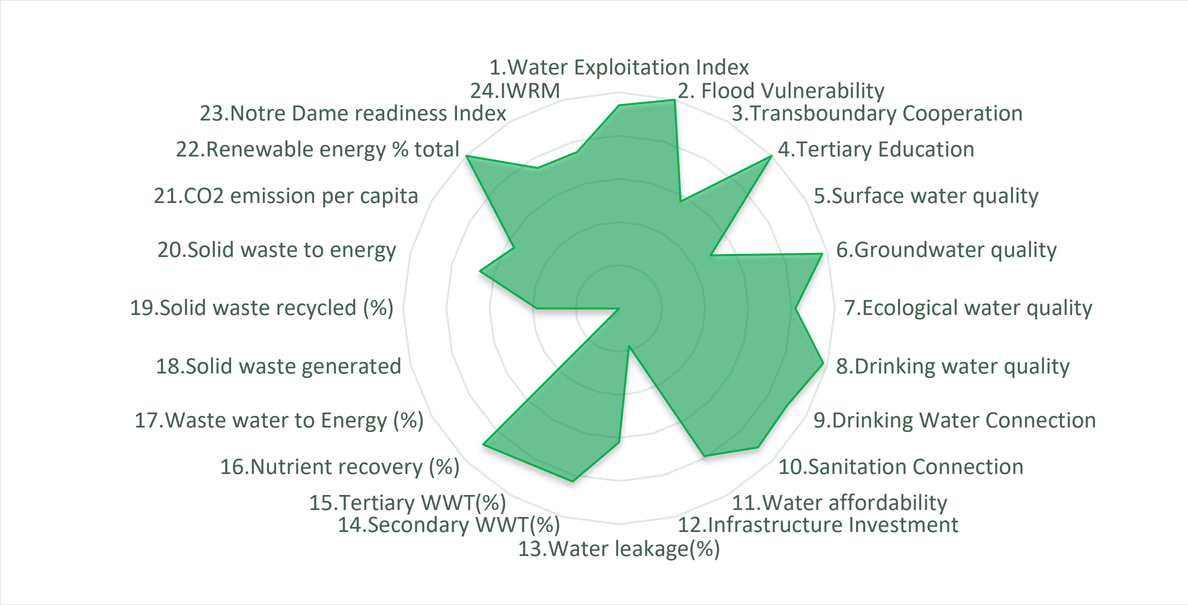
Denmark



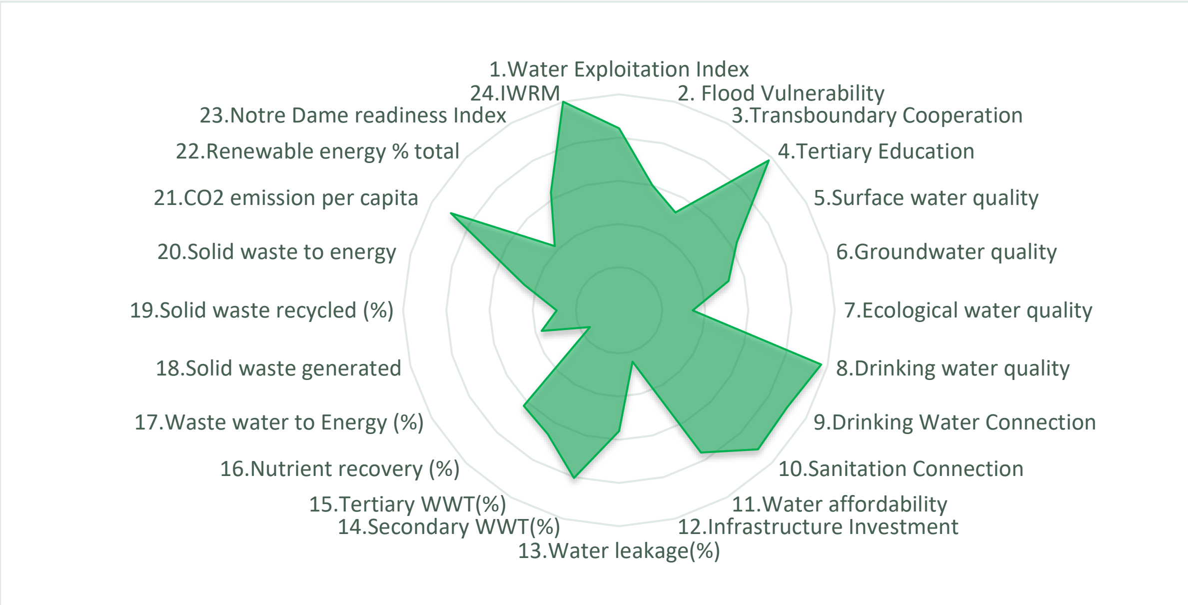
Estonia



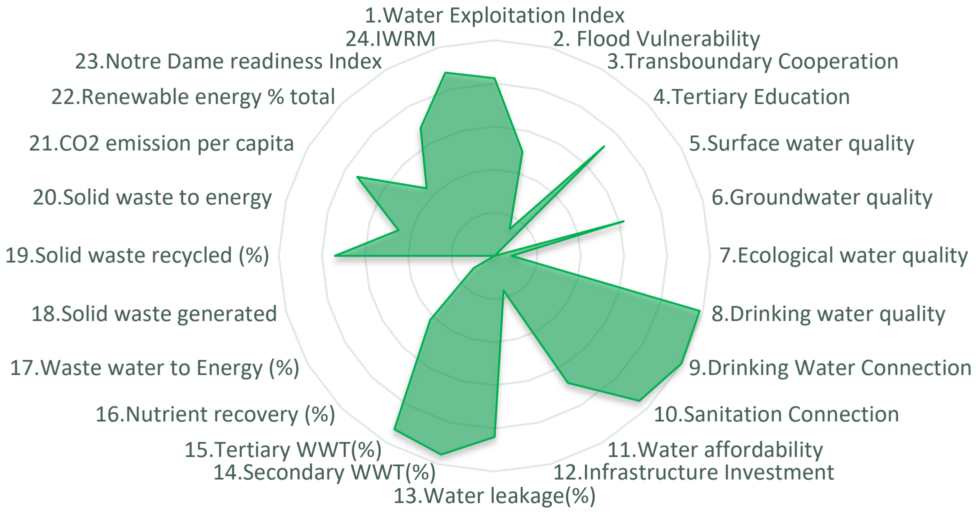
Finland



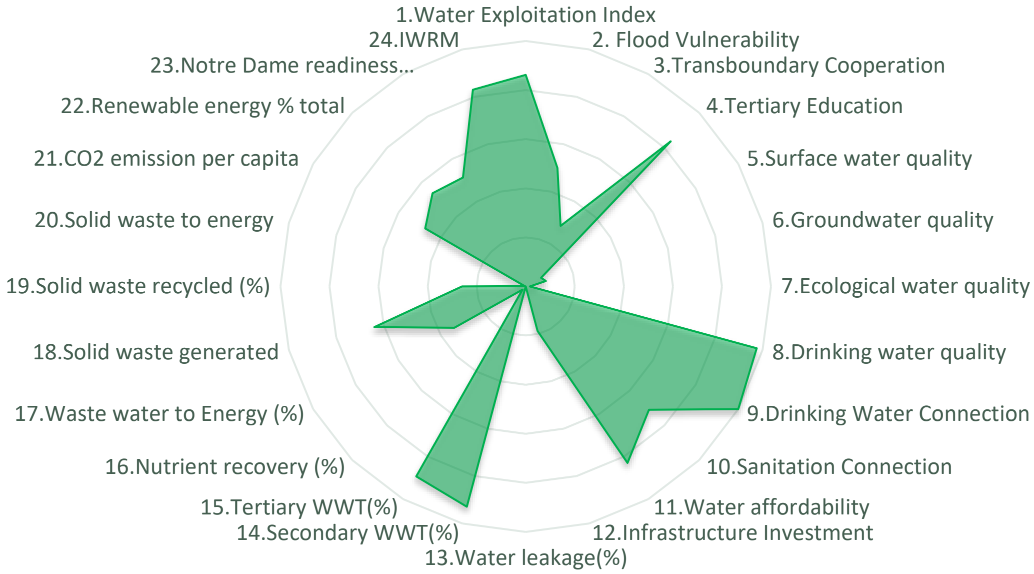
France



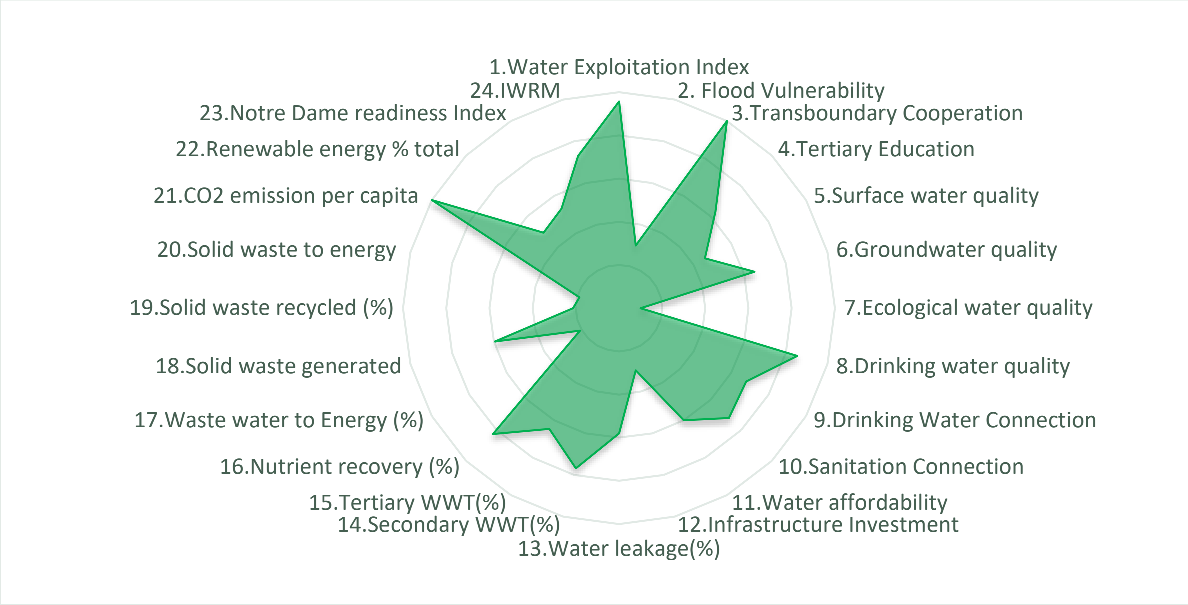
Germany



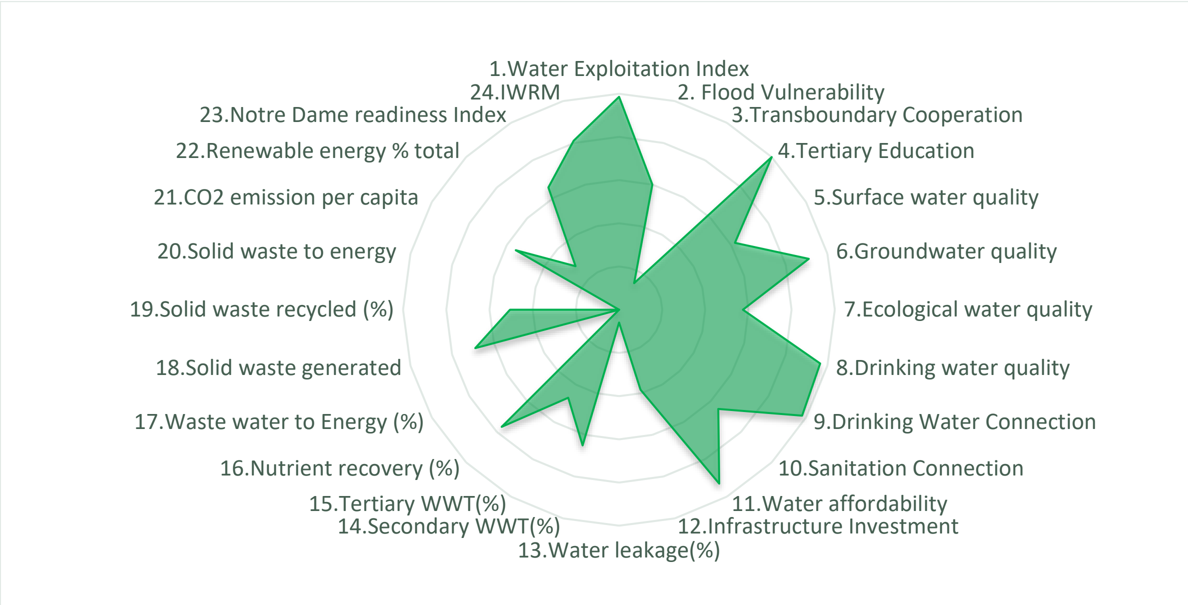
Greece



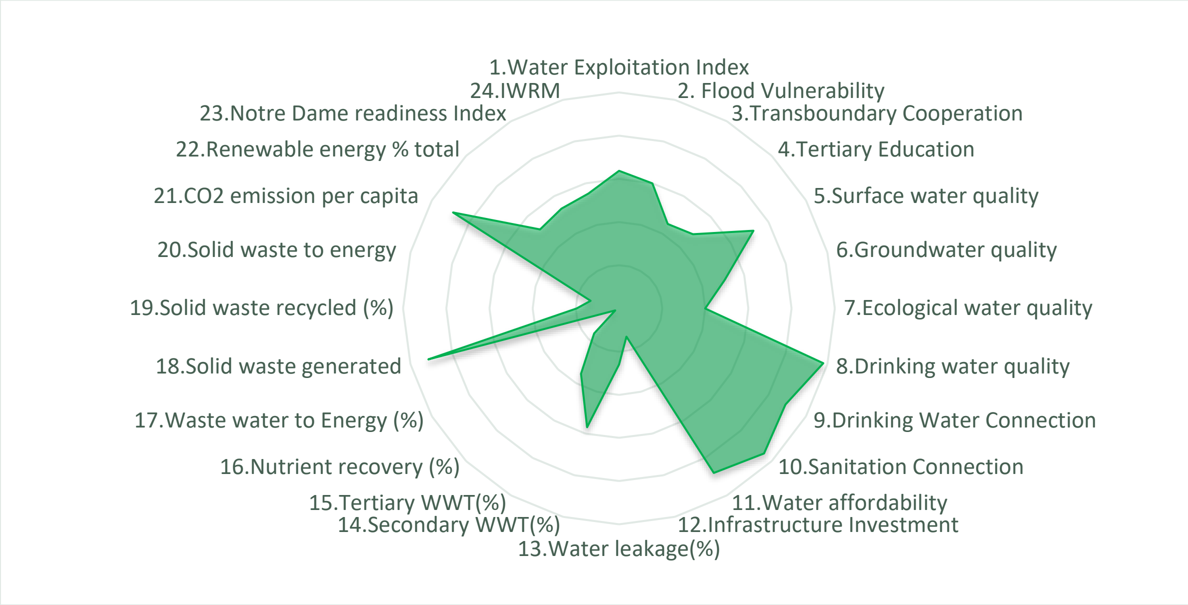
Hungary



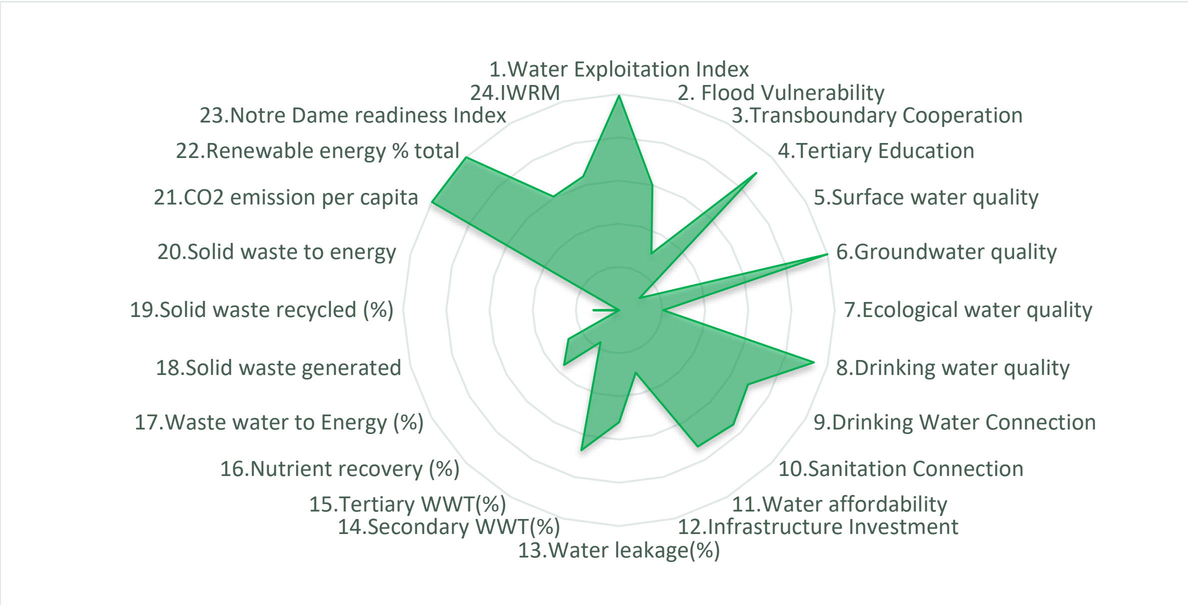
Ireland



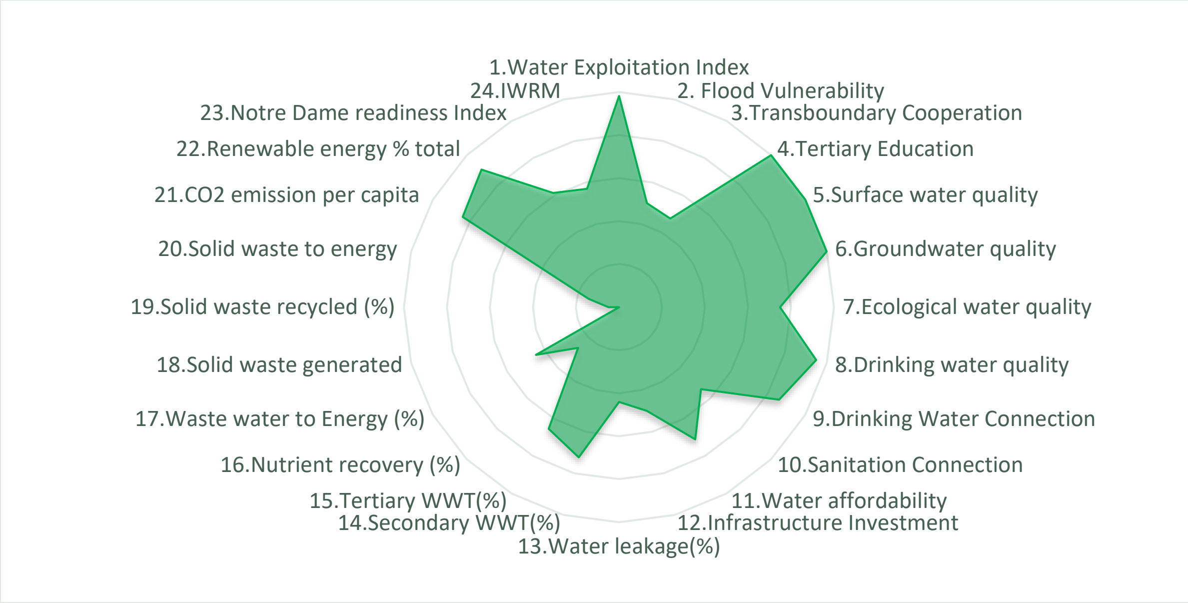
Italy



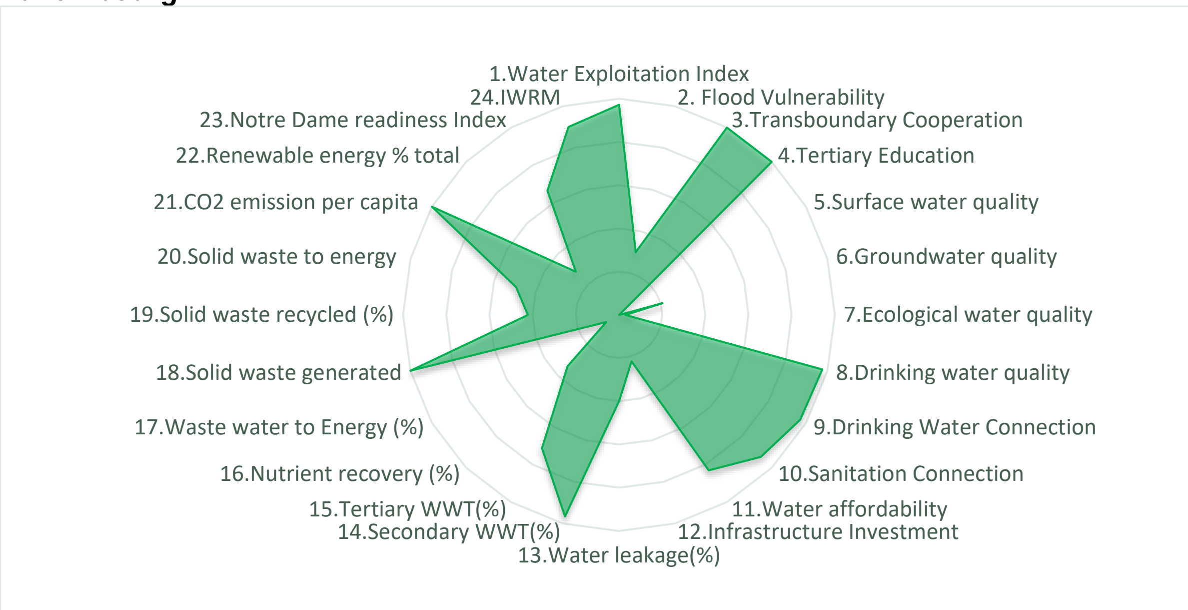
Latvia



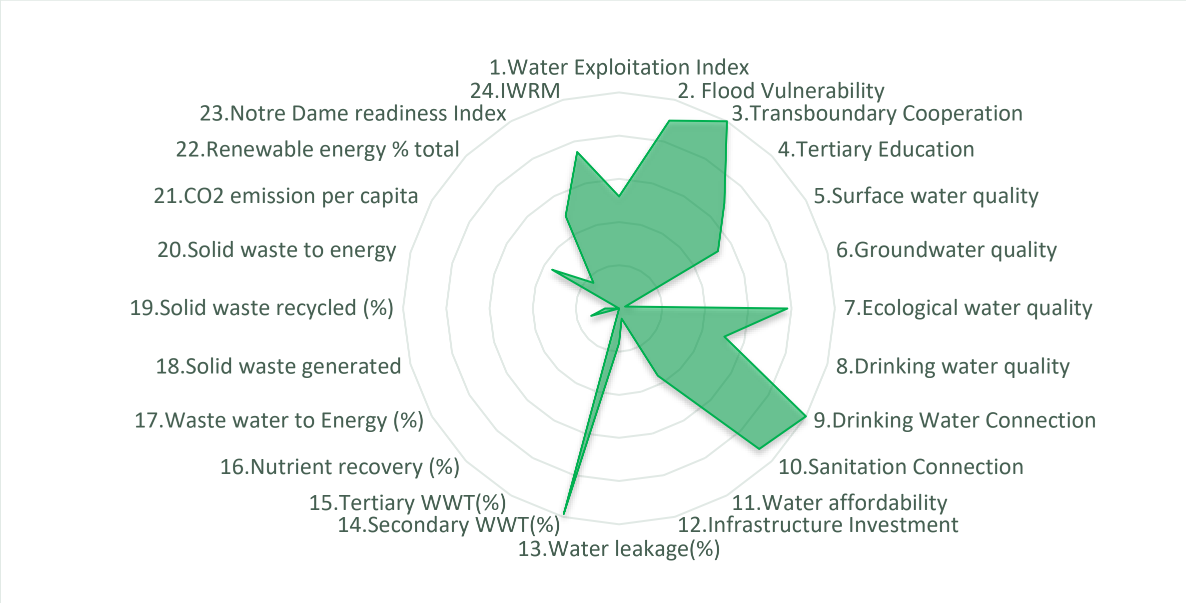
Lithuania



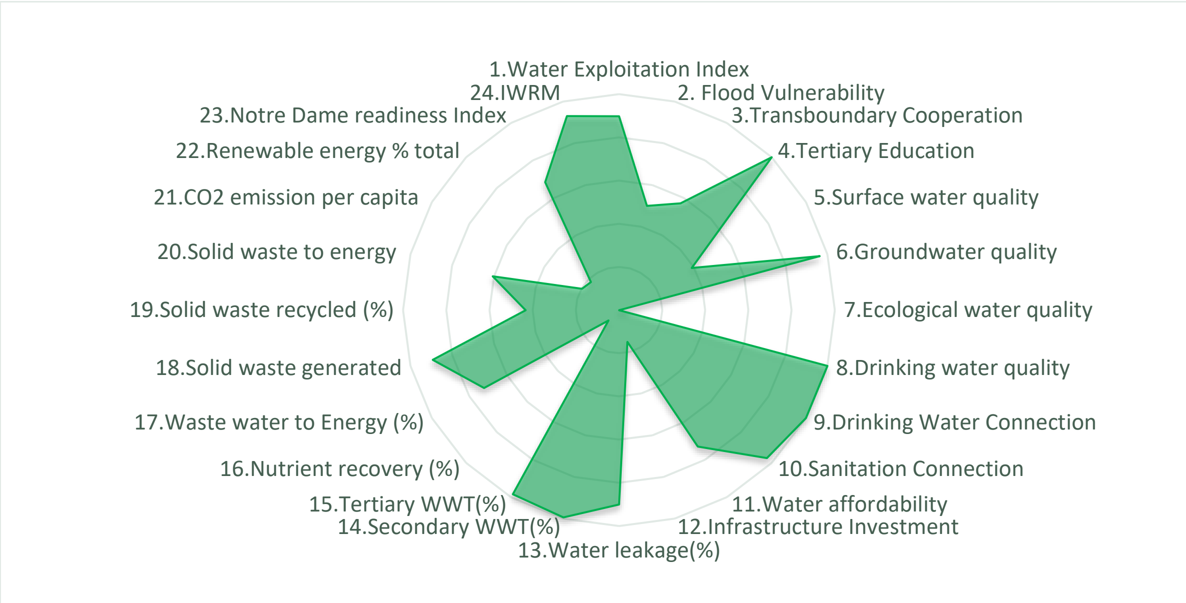
Luxembourg



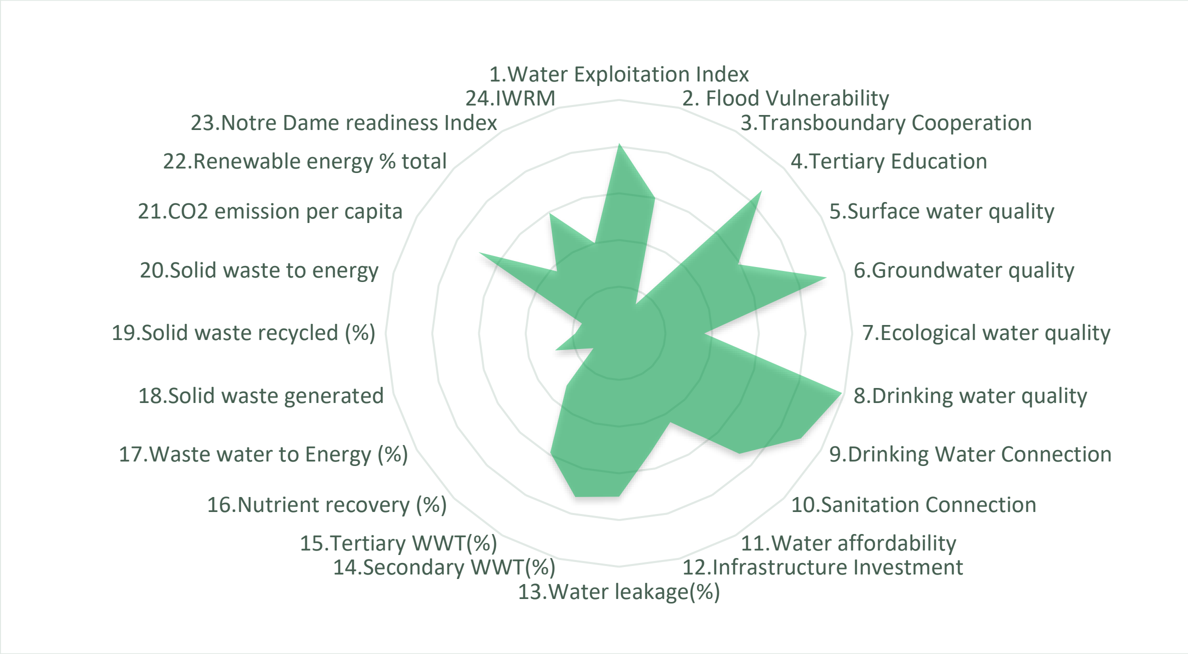
Malta



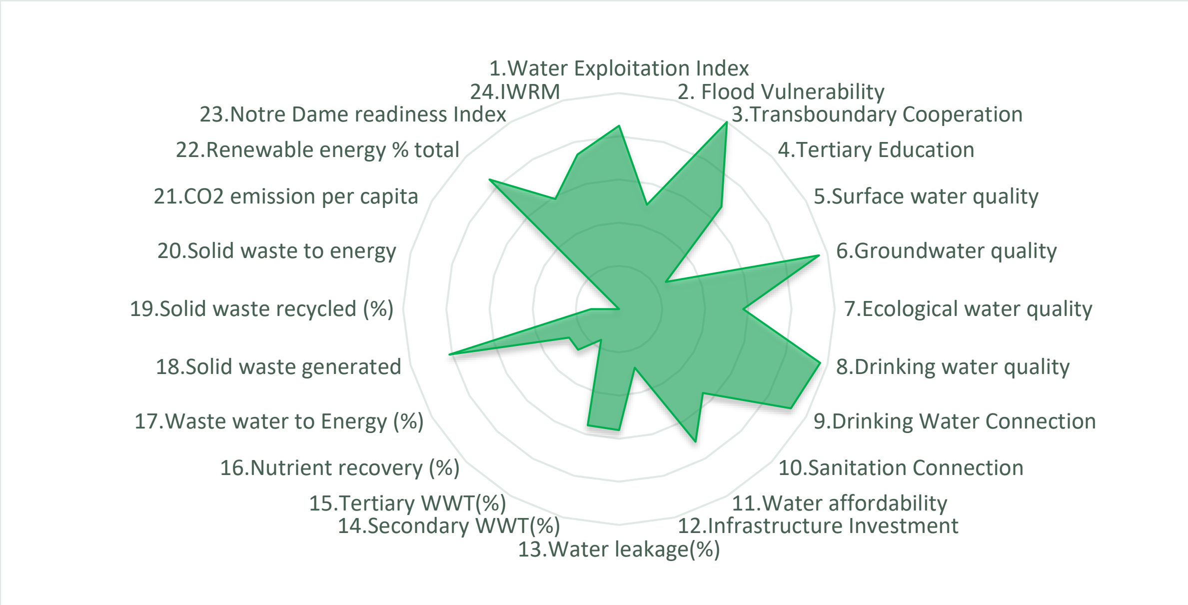
Netherlands



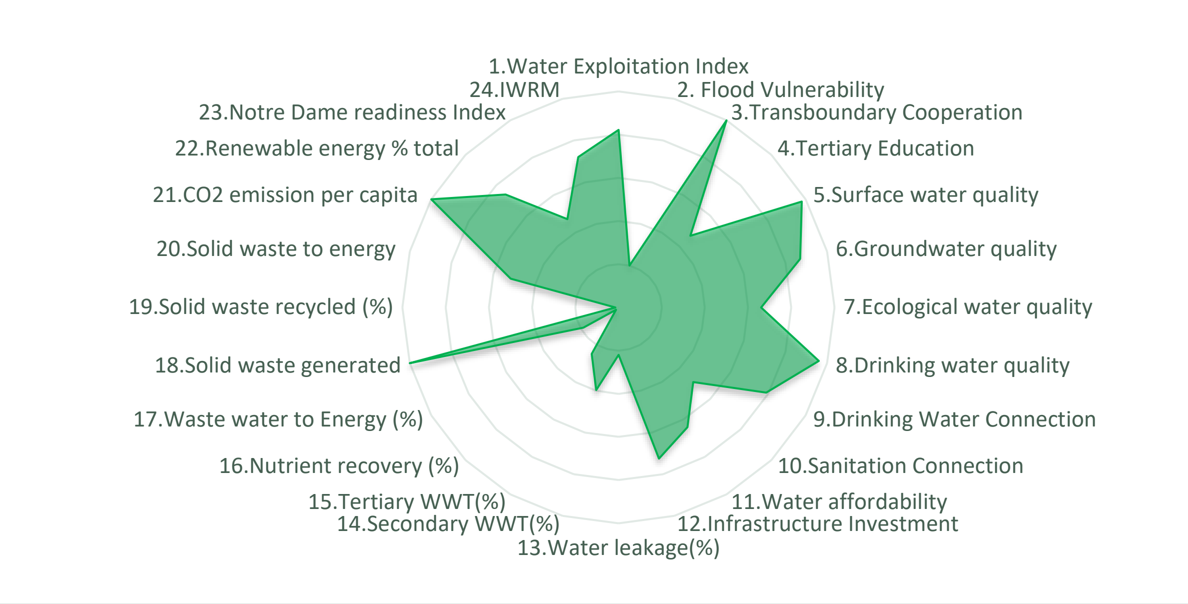
Poland



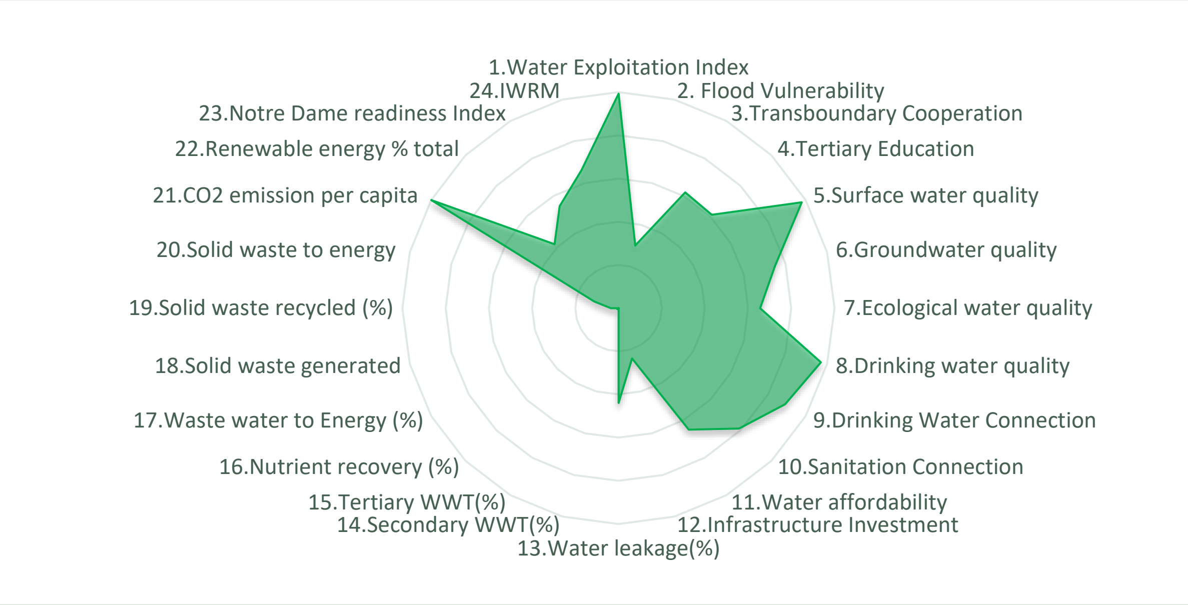
Portugal



Romania



Slovakia



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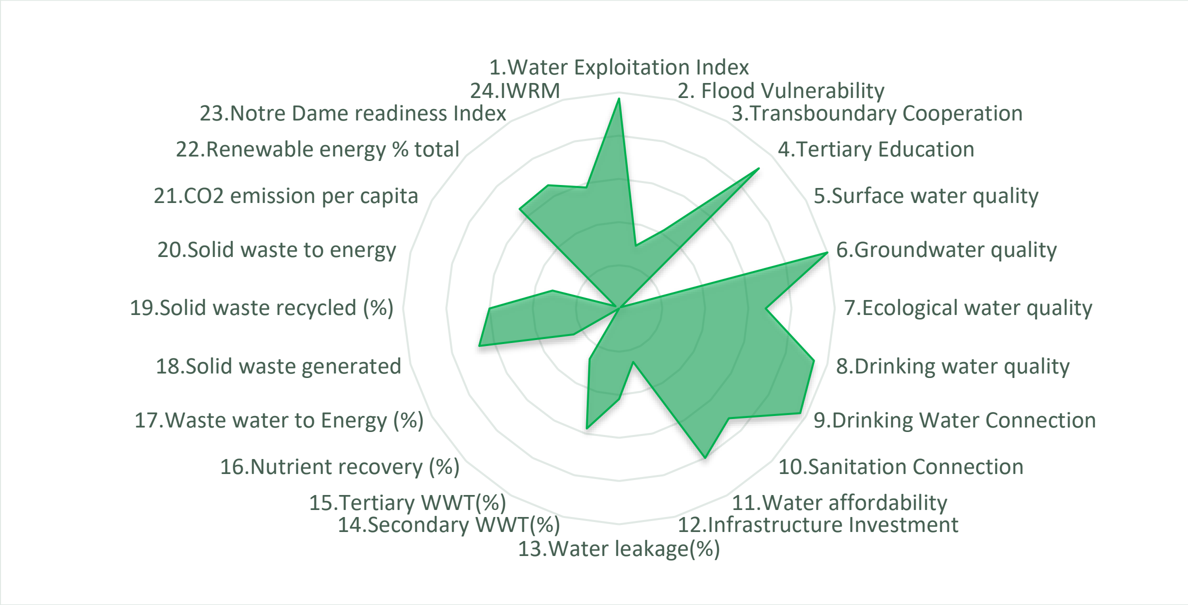
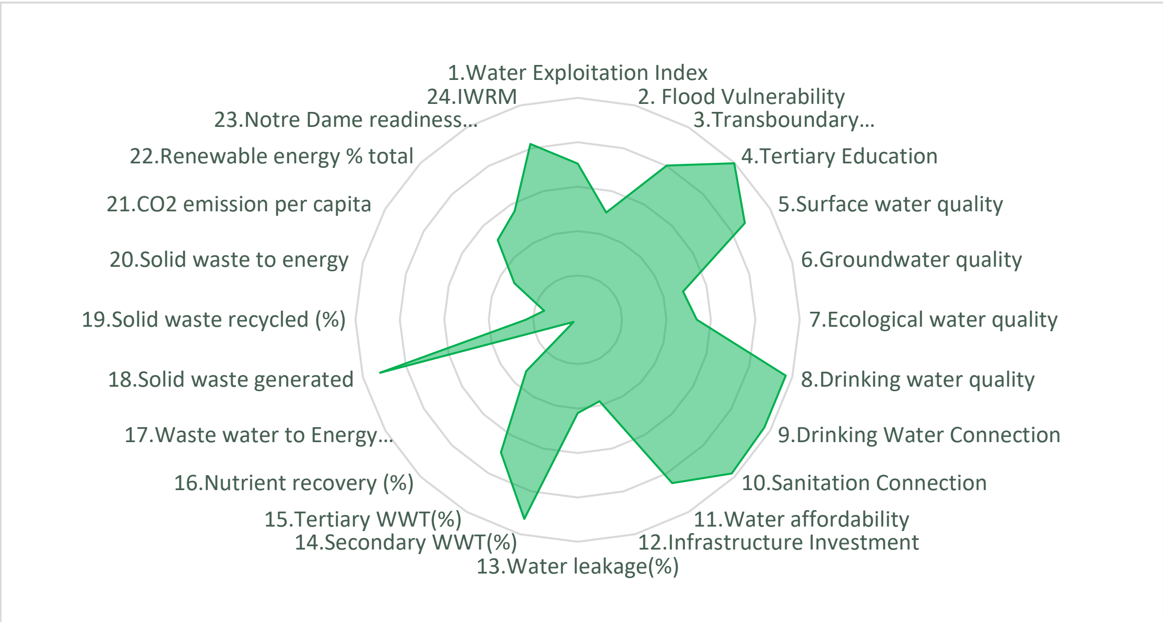
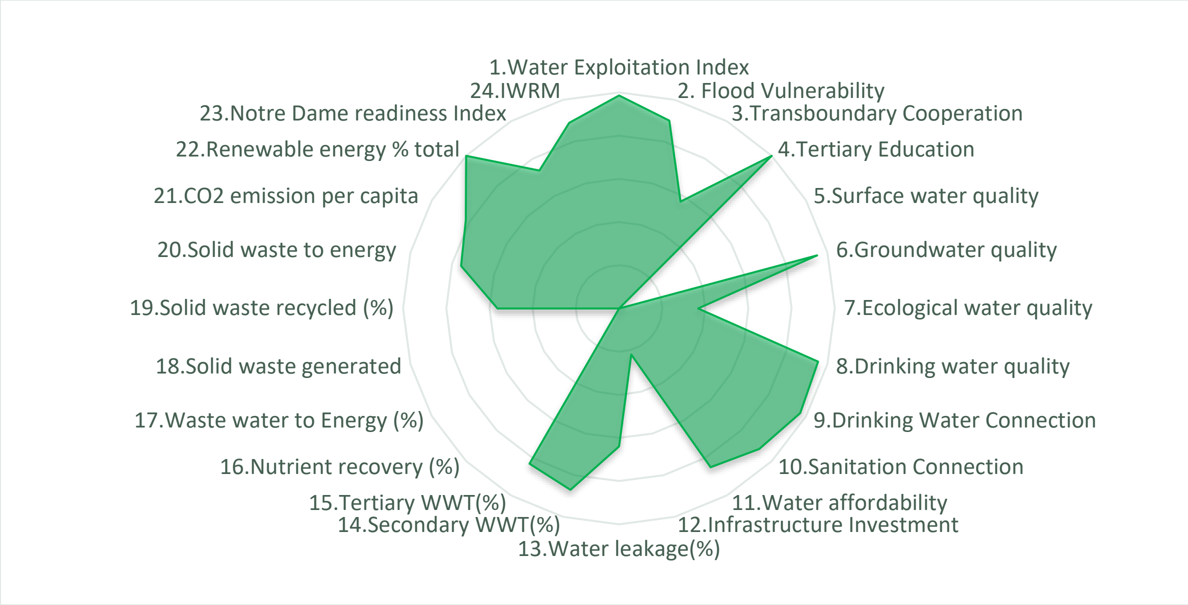


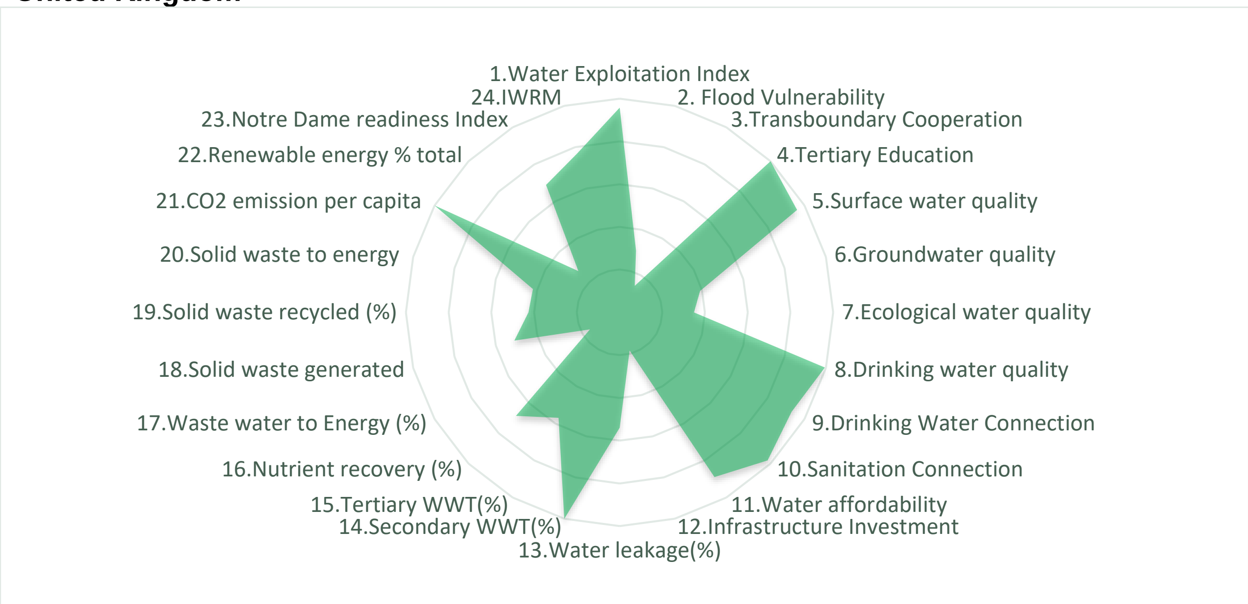
Spain



Sweden



United Kingdom



Annex 4

Pearsons correlation between NBF indicators, first column and first row numbers relate to the individual indicator number of the NBF.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14.	15	16	17	18	19	20	21	22	23	24
1																								
2	-0.39																							
3	0.06	0.43																						
4	0.07	0.43	-0.38																					
5	-0.22	-0.14	0.03	-0.29																				
6	0.49	-0.01	-0.13	0.09	-0.04																			
7	-0.13	0.35	0.02	-0.04	0.40	0.31																		
8	0.48	-0.29	-0.23	0.21	-0.12	0.35	-0.32																	
9	-0.29	0.07	-0.07	0.25	-0.14	-0.39	-0.14	0.00																
10	-0.14	0.35	-0.03	0.40	-0.30	-0.27	-0.28	0.04	0.32															
11	0.16	0.05	-0.21	0.45	-0.19	0.06	-0.10	0.58	0.21	0.23														
12	0.21	-0.38	0.12	-0.23	0.45	0.40	0.22	0.25	-0.39	-0.61	-0.29													
13	0.09	0.08	-0.03	0.23	-0.19	0.25	-0.27	0.23	0.23	0.45	-0.09	-0.19												
14	0.10	0.22	0.06	0.47	-0.48	-0.28	-0.41	0.03	0.29	0.59	0.23	-0.34	0.27											
15	0.26	0.12	-0.13	0.49	-0.45	-0.01	-0.47	0.49	0.25	0.50	0.27	-0.16	0.41	0.74										
16	0.19	0.16	-0.10	0.30	0.04	0.11	0.00	0.23	-0.27	0.20	0.14	0.02	0.11	0.29	0.33									
17	0.16	-0.34	0.03	0.19	-0.24	0.22	-0.40	0.21	0.06	-0.09	-0.06	-0.04	0.24	0.21	0.28	-0.20								
18	-0.04	-0.45	0.35	-0.14	0.01	-0.23	-0.27	0.26	0.13	-0.16	0.31	0.12	-0.30	0.05	-0.02	-0.12	0.27							
19	0.14	0.18	-0.29	0.53	-0.60	0.05	-0.30	0.29	0.46	0.58	0.52	-0.45	0.46	0.50	0.58	0.18	0.12	0.01						
20	0.19	0.21	-0.02	0.41	-0.40	0.19	-0.12	0.33	0.08	0.52	0.13	-0.18	0.42	0.41	0.64	0.12	0.13	-0.09	0.57					
21	0.25	-0.15	0.03	-0.15	0.13	-0.24	-0.25	0.26	-0.20	0.03	-0.11	0.15	0.10	0.03	0.13	0.15	-0.20	0.02	-0.07	0.13				
22	0.42	0.16	0.00	-0.01	-0.21	0.63	0.35	0.15	-0.45	-0.22	0.02	0.21	0.07	-0.10	0.05	0.01	-0.02	-0.42	-0.08	0.19	-0.11			
23	0.43	0.33	-0.23	0.64	-0.46	0.36	-0.05	0.39	0.23	0.56	0.42	-0.30	0.61	0.51	0.62	0.37	0.04	-0.30	0.76	0.65	0.02	0.27		
24	-0.05	0.17	0.03	0.32	-0.22	-0.20	-0.25	-0.07	0.28	0.39	0.22	-0.37	0.23	0.32	0.37	0.10	0.01	-0.14	0.38	0.40	-0.18	-0.01	0.33	