Exploring Intralinkages for UN Sustainable Development Goal 6

Identifying correlations between the target indicators of SDG 6 through statistical data analysis

By

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Foreword

The United Nations World Water Assessment Programme (WWAP) is a UNESCO Programme aiming to develop the tools and skills needed to achieve a better understanding of processes, management practices and policies that help improve the supply and quality of global freshwater resources. Coordinating the UN-Water Task Force for the 2030 Agenda for Sustainable Development, WWAP will aid in the production of a Synthesis Report on SDG 6 that is due for publication in May 2018. The purpose of the Synthesis Report is to inform the discussion of the High Level Political Forum on Sustainable Development taking place mid-2018. An examination of the possible intralinkages of SDG 6 is one of many components that will make up the Synthesis Report. In assignment by WWAP, a preliminary investigation on SDG 6 intralinkages has been executed. The details of its most significant findings are summarized in this report.

DISCLAIMER: The views and conclusions expressed in this thesis are solely those of the author and do not reflect the official position of UNESCO, UN-Water, WWAP, UNEP-DHI Partnership or any other agency involved in the data collection and analysis for SDG data, the 2012 "Status Report on The Application of Integrated Approaches to Water Resources Management" or any other works.

Abstract

The United Nations 2030 Agenda for Sustainable Development defines the mutual values of the international community. These values are captured in the goals as agreed upon by its Member States. Each of the goals has a set of defined targets whose progress can be measured through a change in the associated data indicator. This way, the pursuit of the Agenda becomes an organized, globalized effort that can be tracked, measured and evaluated. While the achievement of many of these goals and targets are inherent in pursuing good politics, as, for example, there are few heads of state that will strive for economic decline (opposite of SDG 8), progress on the overall Agenda can in many other ways become complex. An example of this is when there exists potentially a conflict or synergy between targets of a goal - where improving on one target comes at the cost or benefit of another. This report aims to analyse the possible relationships between the SDG 6 targets. This is done through the comparison and juxtaposition of different data sets that are then evaluated with each other statistically. Given the considerable amount of data constraints, only few possible intralinkages could be identified. No negative trends were discovered, while positive trends were found between the *access to drinking water* (6.1.1) and the following: *integrated water resources management* (6.5.1), *official development assistance for water* (6.a.1) and *water management participation* (6.b.1). Other positive trends were identified with the not-published, national data on *integrated water resources management* (6.5.1) and: *access to drinking water* (6.1.1), *access to sanitation* (6.2.1), and *official development assistance for water* (6.a.1). These results reveal that Integrated Water Resources Management is an effective tool for achieving SDG 6 of the 2030 Agenda on Sustainable Development.

Contents

1 Introduction

Under coordination of the UNESCO World Water Assessment Programme (WWAP), a UN-Water Taskforce will produce a Synthesis Report (SR) on Sustainable Development Goal (SDG) 6: *Water and Sanitation* (working title). The purpose of this Synthesis Report is to inform policy and decision makers, as well as other stakeholders, providing a holistic vision of the water and sanitation issues in the 2030 Agenda.

SDG 6 comprises eight *targets* that can be treated and evaluated independently from each other. These targets are implemented to disintegrate the general goal of '*water and sanitation*' into separate objectives that can be measured in isolation to each other but whose combination shows general progress on SDG 6. Each of the targets has at least one *indicator* dataset associated with it. These *datasets* reflect that state of the *indicator.* The *indicator* quantifies the progress on the *target*. While the set of *targets* make up a more general *goal*.

The current state and recent progress on the targets' indicator data, and thus SDG 6, is one aspect of what will be addressed in the SR. More interesting to policy makers, however, is the recommendations of measures that may be implemented in accelerating progress on SDG 6. For this purpose, the SR hopes to provide evidence for the '*integrated approach'*. The integrated approach recommends a more effective and efficient means to achieve the 2030 Agenda on Sustainable Development by focusing resources on indicators that are also of high influence on other indicators. Progressing on these specific indicators will also facilitate the progress on other indicators. The relationships between such indicators are defined as *intralinkages* when pertaining to indicators within the same goal, and *interlinkages* when they link to indicators of other goals. In assignment of WWAP and for the SR, this additional thesis will explore some of the possible intralinkages of SDG 6.

In this investigation, intralinkages are explored in addressing a research questions in the theme of Water Management and Governance. It explores to what extent Integrated Water Resources Management (IWRM) is an effective tool for SDG 6 implementation, and is formulated as: *What is the correlation between countries ranking high/low in the implementation of IWRM (6.5.1) and their results on the other SDG 6 indicators?* The question will be answered in evaluating a possible correlation of the performance of IWRM (6.5.1) with other eleven SDG 6 indicators (6.1.1 – 6.b.1). Despite the many more possible relations that may exist between the targets of SDG 6, the focus will be to address these guiding research questions given their greater relevance for the upcoming 2018 political summit. In addition to answering the research question, some other, uncovered correlation will be discussed as well.

The introduction will continue with some general information on the Agenda 2030 for Sustainable Development, its SDG's, SDG 6 and the types of intralinkages that may be expected from this study. The second chapter on *Methods and Techniques* begins information on the data used, the form of the data and some background information on its acquisition. It then continues to describe the methodology applied in uncovering the intralinkages. The Results chapter is divided into two subsections, where the first shows the results in answering the research question pertaining to IWRM using the national IWRM dataset; while the second describes the results found in exploring other possible intralinkages within SDG 6, using only the published data. The *Discussion* section expounds on some points that troubled the investigation and what the implications of the data constraints and methodology are on the results. The *Conclusion* is the fifth chapter of the thesis and summarizes the results, answers the research question and provides some recommendations for the Synthesis Report and on future intralinkage studies.

1.1 The Agenda 2030

The 2030 Agenda for Sustainable Development was adopted by heads of state at the United Nations Sustainable Development Summit in New York on September 25, 2015. The decision on the agenda promises global action on improving the lives of people and the state of the planet given a specific set of goals and targets to be achieved. The scope of the issues around which the goals are designed vary enormously as the agenda attempts to address nearly all critical aspects of human wellbeing, economic development and the environment. As ambitious as it is, there exists no doubt to the importance in addressing the issues at hand (Sachs, 2012). Both scientific research as well as statistical analysis confirm that in many aspects the state of the earth is deplorable and that the livelihoods of many of its people are in direct danger on numerous fronts (IPCC 2014). The goals set in the agenda aim to alleviate the stress human populations place on our planet and to unburden communities from the daily struggle against poverty, hunger, disease, and gender inequality. The goals decided upon at the summit can be found in the declaration (General Assembly A/RES/70/1) and sounds as followed:

1. End poverty in all its forms everywhere
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3. Ensure healthy lives and promote well-being for all at all ages
4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5. Achieve gender equality and empower all women and girls
6. Ensure availability and sustainable management of water and sanitation for all
7. Ensure access to affordable, reliable, sustainable and modern energy for all
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
10. Reduce inequality within and among countries
11. Make cities and human settlements inclusive, safe, resilient and sustainable
12. Ensure sustainable consumption and production patterns
13. Take urgent action to combat climate change and its impacts
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17. Strengthen the means of implementation and revitalize the global partnership for sustainable development

There is no strict hierarchy in importance of the goals, as the current state of each will differ significantly per Member State. It is thus up to the Member States individually to determine what form their approach should take in working towards 2030. A global *plan de course* that is applicable to all nations is therefore not available. Instead, to aid this and other decision-making concerning the 2030 Agenda, various UN departments and independent research institutes will continue to publish informative and advisory reports on the SDG's. These provide a wide range of new information concerning everything from case studies to data trends, from policy briefs to small intralinkage studies like this. The upcoming UN-Water SR on SDG 6 is one of these reports that will recommend strategies in accelerating the achievement of the Agenda. The SR is of greater importance than other reports, however, as it will receive the direct attention of the policy and decision makers with its presentation at the 2018 summit.

1.2 Sustainable Development Goal 6

The importance of water and sanitation in the sustainable development agenda is captured in SDG 6. In stressing the importance of water and sanitation, the UN references to various statistics among which the most striking are that: 946 million people still lack access to sanitation facilities, in 2012 some 1.8 billion people were exposed to contaminated drinking water and that 2 billion people are affected by water stress (E/2016/75). The indicators of SDG 6 are determined by an Inter-Agency Expert Group (IAEG) which has been congregated by United Nations Department of Economic and Social Affairs Statistics Division (UNDESA-SD) (IAEG, 2016). The chosen indicators are a compromise of being most 'indicative' of the target, easily measurable, and well understood variables in order to guarantee that comparison is possible in a justifiable and equable manner. Below is a list of the determined indicators for SDG 6:

- 6.1.1 Proportion of population using safely managed drinking water services.
- 6.2.1 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water.
- 6.3.1 Proportion of wastewater safely treated.
- 6.3.2 Proportion of bodies of water with good ambient water quality.
- 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
- 6.5.1 Degree of integrated water resources management implementation.
- 6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation.
- 6.6.1 Change in the extent of water-related ecosystems over time.
- 6.a.1 Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan.
- 6.b.1. Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management.

On a yearly basis, the Statistics Department compiles and homogenizes the available data for publication on an UNDESA domain[1].

1.3 Linkages

The *Water and Sanitation Interlinkages* report by UN-Water identifies four different types of linkages (UN-Water, 2016):

1) 'Interdependent: where achieving one is a requisite for achieving the other. An example for this is how achieving access to water supply and sanitation (6.1, 6.2) is required for reducing poverty in all its dimensions (1.2).' By this definition, indicator 'A' cannot be achieved without the achievement of indicator 'B'.
2) 'Constraining: where one restricts the ways in which another may be achieved. For example, sustaining economic growth may restrain the extent to which water quality and sustainable supply of fresh water may be used.' Here, progress on indicator 'A' will reduce the progress on indicator 'B'.
3) 'Reinforcing: where achieving one will help progress on another. IWRM (6.5) and social, economic and political inclusion (10.3) are considered mutually reinforcing.' An improvement on indicator 'A' will improve on indicator 'B' and 'B' will improve on 'A'. Where 'A' and 'B' are interdependent, they are also always reinforcing. However, not every reinforcing relationship implies interdependency.
4) 'Related: where one goal or target may reinforce or constrain another depending how and what policies are implemented. Access to modern energy services (7.1) can have positive/negative impact on water related ecosystems (6.6).' Indicator 'A' is of influence on indicator 'B' either positively or negatively depending on the nature of the measures implemented in the achievement of 'A'.

Identification of a linkage or causal relationship requires both thorough quantitative as well as qualitative analysis. In context of the above-defined terms, qualitatively the following theoretical relationships could exist for the *available* SDG 6 data. Statistical analysis will have to show to what extent these relationships can be identified from the data.

Table II. *Theoretical SDG intra-linkages for available data*

Interdependent:	6.5.1	depends largely on	6.a.1 and 6.b.1
Reinforcing:	6.5.1	reinforces	6.1.1, 6.2.1, 6.4.2, and 6.b.1
	6.a.1	reinforces	6.1.1, 6.2.1, 6.5.1, and 6.b.1
	6.b.1	reinforces	6.1.1, 6.2.1, 6.4.2, and 6.5.1

From table II, it is clear that there exist two categories of indicator types within SDG 6. There are those indicators that are a direct, concrete, measurement of an ultimate goal (safe drinking water and sanitation

[1] https://unstats.un.org/sdgs/

access (6.1.1, 6.2.1) and low natural water stress (6.4.2))- on the right hand side of table II and in category 1 in table III; And there are those indicators that also provide a *means to achieving* those ultimate goals (IWRM (6.5.1), water financing (6.a.1), and participation (6.b.1)), on the left hand side of table II, category 2 in table III. The latter set of targets influences the first set of targets, but are also targets in and of themselves. Their influence is much greater than solely on those other targets of category 1, thus justifying their own 'target' status. The wide influence of 6.a.1 (Financing), for example, effects many more indicators beyond the scope of those indicators captured in the Agenda, yet at the same time there is no need for more financing if there were no issues surrounding water.

Table III. *Target type grouping*

Rel.	Ind.	Category 2	Ind.	Category 1
1.	6.5.1	Degree of IWRM implementation	6.1.1	Proportion of population using safe drinking water
2.	6.a.1	Water related government spending assist ODA	6.2.1	Proportion of population using safe sanitation
3.	6.b.1	Administrative units with policies for participation	6.4.2	FW withdrawal as a prop of FW resources

2 Methods and Techniques

The *Methods and Techniques* section has two subsections. The first covers general information on *the data* while the second describes the procedure in executing the correlation analysis. 'Other' methods and techniques that do no directly relate to answering the research question, such as those pertaining to a data format translation, are mentioned in Appendix V: *IWRM Data Translation*.

2.1 The Published Data

With the signing of the Agenda on Sustainable Development in 2015, the eight targets of SDG 6 were set in stone. The Inter-Agency Expert Group (IAEG) was tasked with creation of a global indicator framework for these targets which was presented at the United Nations Economic and Social Council (ECOSOC) during its 70th session in June 2016. The framework consisted of the 230 indicators on which agreement had been reached with eleven of these indicators pertaining to the eight SDG 6 targets. Four of the eight SDG 6 targets have indicator datasets associated with them that have their foundation in long running, existing programmes led by the World Health Organisation (WHO) and a partnership of WHO/UNICEF. These are the Global Analysis and Assessment of Sanitation and Drinking-water (GLAAS) and the Joint Monitoring Programme for Water and Sanitation (JMP) - as known from the Millennium Development Goals (MDG), respectively (WHO/UNICEF, 2015). The other four datasets were introduced as new, and their monitoring falls under the **GEMI program** (established in 2014). GEMI is a collaboration of an extensive amount of UN affiliated organisations and departments, whose four specific objectives are to (UN-Water, 2015):

- Integrate and expand existing monitoring efforts, to ensure harmonized monitoring of the entire water cycle
- Provide Member States with a monitoring guide for SDG targets 6.3-6.6
- Engage Member States and enhance their capacity in water sector monitoring
- Report on global progress towards SDG targets 6.3-6.6

In line with other UN reports and the IAEG indicator recommendations, the choice was intitally made to only work with the UNDESA-SD approved data that is published on the data portal and not with data from other sources. Datasets from other sources often follow a different methodology in data acquisition and will therefore show differences with the UN-approved data sets. Since they are not recommended by the IAEG, their utilization in context of the Sustainable Development Agenda should be avoided to prevent confusion. Unfortunately, official and published data is only available for a little more than half of the indicators (54%) (March 2017). Apart from data availability issues, the analysis is further troubled by an inconsistency in spatial and temporal scales among the available datasets. For the latter reason, the UNEP-DHI partnership that provides the IWRM data was contacted for a spatially more precies IWRM dataset.

Of the *newly introduced* indicators, only the existing datasets of on IWRM (6.5.1), as provided by a running programme by UNEP-DHI; and water stress (6.4.2), provided by a running AQUASTAT programme from FAO, are available and/or UN-approved and published online on the SDG data portal. Together with the four GLAAS and JMP datasets, this provides the community with 6/11 promised SDG 6 datasets (54%) to work with. Of these, only 3/6 (50%) can be considered globally complete at national scale (6.1.1, 6.2.1, 6.a.1), while 6.a.1 is not the promised data. In the end, only 2/11 (18%) of the promised data is available at national scale and for at least one year. Both these datasets (6.1.1 and 6.2.1) do not technically follow the IAEG definition of the indicator either. The data sets as they are currently available are the old MDG-sets of: 'Proportion of population using an improved drinking water source' and 'Proportion of population using an improved sanitation facility'; whereas the new IAEG indicator specifies: 'Proportion of population using **safely** managed drinking water services (6.1.1)' and 'Proportion of population using **safely** managed sanitation services, including a hand-washing facility with soap and water (6.2.1)(IAEG, 2016). Similar to this, 6.a.1 and 6.b.1 also do not adhere to their IAEG definition either. This will be explained per indicator later in this section. Table V summarizes the data on SDG 6 as is available on UNDESA-SD website.

Table III. *Data Summary*

Ind.	Status	Temporal	Spatial	Notes
6.1.1	Complete[2]	2000-2015	National	Technically not indicator data
6.2.1	Complete	2000-2015	National	Technically not indicator data
6.3.1	Not available	-	-	-
6.3.2	Not available	-	-	-
6.4.1	Not available	-	-	-
6.4.2.	Partially complete	2002,2007,2012	National	Inconsistent
6.5.1	Partially complete	2012	Regional	-
6.5.2	Not available	-	-	-
6.6.1	Not available	-	-	-
6.a.1	Only Developing Countries	2000-2014	National	Technically not indicator data
6.b.1	Only Developing Regions	2014	Regional	Technically not indicator data

The AQUASTAT data on **water stress (6.4.2**) spans for 3 years at 5 year intervals (2002, 2007, 2012). Unfortunately, the data reporting is so inconsistent that it makes global year to year comparison difficult. Where 129/212 (61%) of the considered countries report data for 2002, only 51% did so for 2007, and 65/212 (31%) for 2012. In total, only 29 countries reported consecutively for the 3 assessment years, of which the vast majority (76%) lie within the developed region. Comparison becomes difficult as the concentration of the other datasets is predominantly on the developing regions/countries.

2.1.1 Data pertaining to management and governance

The social aspects of management and governance on SDG 6 are captured in the indicators 6.5.1, 6.a.1, and 6.b.1 (of the ones available). These three indicators are measures of the social, institutional and financial constructs that facilitate good water management. Indicators 6.1.1, 6.2.1. and 6.4.2. are of a more physical nature which are, partially so, influenced by the other three indicators - as explained in section 1.3 of the introduction.

For **IWRM (6.5.1),** the Global Water Partnership defines Integrated Water Resource Management (IWRM) as 'the process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems'(WWAP, 2009)[3]. The 6.5.1 metadata file explains IWRM quantification through evaluation of the following components (UNDESA-SD, 2017 I):

1. *Enabling environment:* this includes the policies, laws, plans and strategies which create the 'enabling environment' for IWRM.
2. *Institutions:* includes the range and roles of political, social, economic and administrative institutions that help to support the implementation of IWRM.
3. *Management Instruments:* The tools and activities that enable decision-makers and users to make rational and informed choices between alternative actions.
4. *Financing:* Budgeting and financing made available and used for water resources development and management from various sources.

[2] 'Complete' implies that data is available for the vast majority of the countries or regions; >90%, while 'Partially complete' implies anywhere between 50-90%.
[3] http://www.un.org/waterforlifedecade/iwrm.shtml

The IWRM survey programme currently has completed two global survey rounds, one in 2007, another in 2012, and has a third coming for 2017. Where the survey responses would allow for the presentation of the data at a national resolution, the data for the SDG assessment is currently only available at a regional scale. Neither information on the performance with regards to the different 2012 IWRM survey components nor a 0-100 score is provided. Instead, only the responses to one of the 2012 survey questions is published as the 6.5.1 data on the SDG data portal, which is presented as the **proportion of countries in a region** satisfying one of the following conditions:

1. Proportion of countries that have ***fully implemented*** national integrated water resources management plans or equivalent
2. Proportion of countries that are at ***advanced stage*** of implementation of national integrated water resources management plans or equivalent
3. Proportion of countries that have ***started implementing*** national integrated water resources management plans or equivalent
4. Proportion of countries that have ***developed but are not yet implementing*** national integrated water resources management plans or equivalent
5. Proportion of countries where national integrated water resources management plans or equivalent are ***under development***
6. Proportion of countries where national integrated water resources management plans or equivalent are ***not relevant***

To combine these 6 data subsets into a single one, a sum of 1, 2 and 6 is taken. This results in a new category that is used as the indicator for 6.5.1 in the analysis with only the published data, namely the proportion of countries that have ***fully implemented (1) or are at an advanced stage (2) of implementation*** of national integrated water resources management plans or equivalent (excl. countries for which it is not relevant (6)). More simply put, this category then captures the proportion of high IWRM countries in a region. The remaining classes 3, 4 and 5 are more indicative of countries that are on their way, which are captured in the remaining percentage.

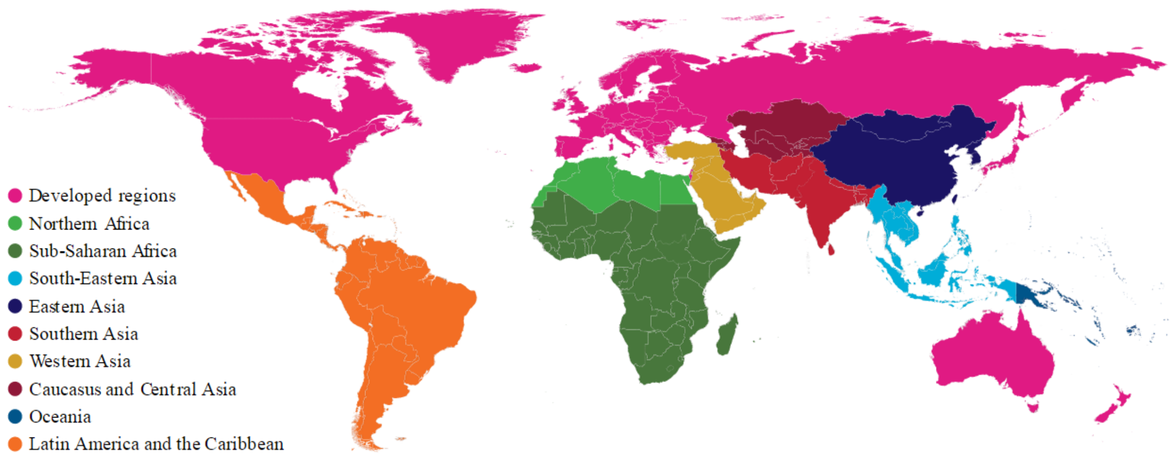
Coordinated Government Water Spending (6.a.1), the amount of water- and sanitation-related official development assistance (ODA) that is part of a government coordinated spending plan, is defined as the proportion of total water and sanitation-related ODA disbursements that are included in the government budget. The metadata file for 6.a.1 defines water and sanitation-related activities and programmes as those for: water supply, sanitation and hygiene (WASH) (targets 6.1, 6.2), wastewater and water quality (6.3), water efficiency (6.4), water resource management (6.5), and water-related ecosystems (6.6). As per target 6.a wording, it includes activities and programmes for water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies. In summary, it is a measure of the amount of money invested in water projects by donor countries that coincides with the water development plans of the recipient developing country. A low value would imply that investments in the water sector are made by the donor countries without coordination with the recipient government, or not at all. A high value would imply the opposite - that investments are in alignment with the recipient country's water relevant spending policy. However, in actuality, there is no data for 6.a.1 (Government aligned ODA spending). Instead current published data for 6.a.1 is presented as the 'total official flows for water supply and sanitation, by recipient' in millions of USD. The term 'recipient' is not defined, but presumed to be the 'recipient' nation. Despite the focus of the data of 6.a.1 on developing countries, it provides a relatively complete set for most of these over the extensive period of 2000-2014. It is also the only category 2 data set (a dataset that impacts the first three ultimate targets of 6.1.1, 6.2.1 and 6.4.2.) for which a substantial amount of data is available - even if only for a selection of specific countries and not following IAEG definition. Along with the remaining two datasets for 6.1.1 and 6.2.1, these three dataset allows for most analysis with regards to intralinkages between them because of the long time running programmes they are part of and because the data is available at national scale. For more information on the complex definition of this indicator, the reader is encouraged to read the metadata file for 6.a.1.[4]

Policies and procedures for local community participation (6.b.1) is indicative of the proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management. It is measured as 'the presence or absence in a country of clearly defined procedures in law or policy for participation by service users/communities in planning program in i) water, ii) sanitation and iii) hygiene management, and the presence or absence in a country of a high level of users/communities participating in planning programs in i, ii, or iii'. The data is disaggregated by urban, rural and total population for both water- and sanitation management, and with its current availability thus results in a total of 14 sub-data sets. It is the second data set that provides data only for a single year and at regional resolution. Despite GLAAS' premiere assessment round debuting in 2009/2010, the data for 6.b.1 is only available for 2014. Presumably, this is because participation was not a target of the data collection procedure before then as the 2010 report does not mention it (WHO, 2010).

2.1.2 National vs. Regional Data

The IWRM dataset, the dataset that is the focus in our research question, provides a spatial accuracy not at national scale, but at regional scale. The UNDESE-SD regional division of the world is shown in map 1. The groupings are based on United Nations demographical divisions that are defined in a way so that meaningful analysis may be carried out. Because there is no established convention for the designation of "developed" and "developing" countries or areas in the United Nations system, this distinction is made for the purposes of statistical analysis only (UNDESE-SD, 2017). In many cases, finer scale dataset inevitably had to be coarsened in order to make comparison and correlation analysis possible.

Map 1. *Regional division of the world*



Data comparison between a national and regional dataset may in some cases cause for confusion. The WHO GLAAS project compiles national data while focusing on developing countries. In addition to national scale, it is available for a WHO grouping of: developing regions, landlocked developing countries, least developed countries, and small island developing states. For consistency reasons, an average was calculated for the UNDESA-SD demographical divisions instead by taking the regional average of all countries for which there is an ample amount of data in both indicators for each region. The data for the GLAAS UNDESA-SD calculated regions can be somewhat misleading as the new regional average

[4] https://unstats.un.org/sdgs/metadata/

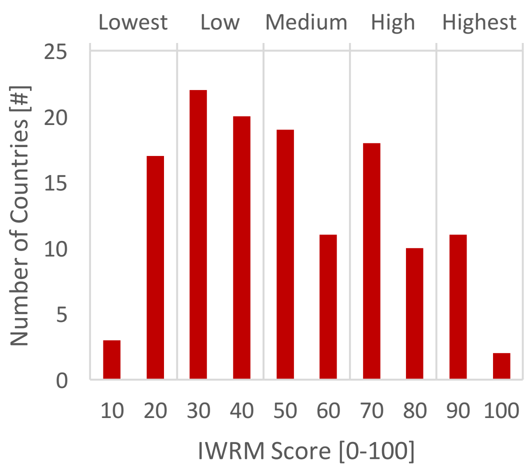
represents solely the average of that regions' GLAAS targeted, *developing* countries, and not the region as a whole (with developed countries included).

2.2 The National IWRM Dataset for 2012

The UNEP-DHI Partnership is IAEG mandated with the collection of IWRM data for 6.5.1. Even though not *publically* available on the SDG data portal, the national-scale IWRM survey results were shared for the purpose of this study. The methodology of translating these survey results into the 6.5.1 SDG dataset is expounded upon in appendix II.

There currently exist two IWRM questionnaires: one for 2007, one for 2011, with another one coming for 2017. Each of the questionnaires is different from the last as improvements are given the learning process and the shifting of international focus from emphasizing the importance of one IWRM aspect to another. The new, 2017 questionnaire is structured around acquiring accurate data for indicator 6.5.1 and is therefore more concise than the other questionnaires. This is well exemplified in the number of questions; where the 2011 survey counted 93 questions for the first four components, the new, 2017 survey counts 32 (34%). Although the number of questions is different, the question format of each survey is very similar. Some changes have been made to the different thresholds, however. The 2007 survey had four thresholds and the 2011 survey has five. For the 2011 survey, the five thresholds were: not relevant, under development, developed but implementation not yet started, implementation started, implementation advanced and fully implemented. The 2017 survey was expanded further as it was designed to have eleven thresholds (scores of 0-100 in increments of 10). This would allow for a more accurate distinguishing between the differences in IWRM performance among the nations. Apart from the different number of thresholds, the 2017 survey is also different in that guiding threshold descriptions are provided per question. These guiding criteria are introduced to reduce the subjectivity in interpretation of the 2011 thresholds, which should lead to more accurate responses. Despite differences in the content of the surveys, the general procedure in surveying remains the same; where the same survey is sent out to the different governments whose water-related ministries or institutes appoint an individual or group to then answer the questions and submit their answers and final score back.

Figure 1. *IWRM Data Histogram 2011*



Each of the surveys approximates the IWRM performance of different nations by the same criteria therefore allowing for good comparison between the nations on IWRM performance in each year. Though the different surveys allow for the simple comparison *between nations*, an evaluation of a single nation's development on IWRM *over time* through a comparison of survey results becomes more challenging. Nevertheless, this has been attempted in this investigation through a procedure of identifying comparable questions, grouping and aggregating their responses and then rescaling them into the same, defined threshold range. The methodology applied in translating the 2011 survey data into the 2017 data format is further described in Appendix V: *IWRM Data Translation*. Especially once the 2017 data is released, this translation will allow for more intricate analysis on the progress nations have made with regards to IWRM, and the effects of this change on other indicators. For now, it will serve as our 6.5.1 data set for 2011 but then at national scale resolution as opposed to the published regional scale. It is also noteworthy to mention that unlike the requirement for the 2017 data, in 2011 no attempt was made to aggregate the data into a single score on IWRM. This is now a requirement to be able to track progress on 6.5.1, and is hence another reason for this exercise. Figure 1, a histogram on the 6.5.1 data, shows the slightly skewed, normal distribution of IWRM scores among the nations for which there is data in 2011 (133). The 2011 survey was sent out to 192 nations; the response rate is thus approximately 69% (133/192).

When calculating the regional average IWRM scores, it is noticeable that most regions score within the 40-50 range, somewhere in between the 2011 thresholds of 'not yet implementing' and 'started implementing' (Table IV). By far the most data is available for the Developed Region and Sub-Saharan Africa (Figure 2).

Figure 2. *Number of Countries with IWRM data by Region [2011]*

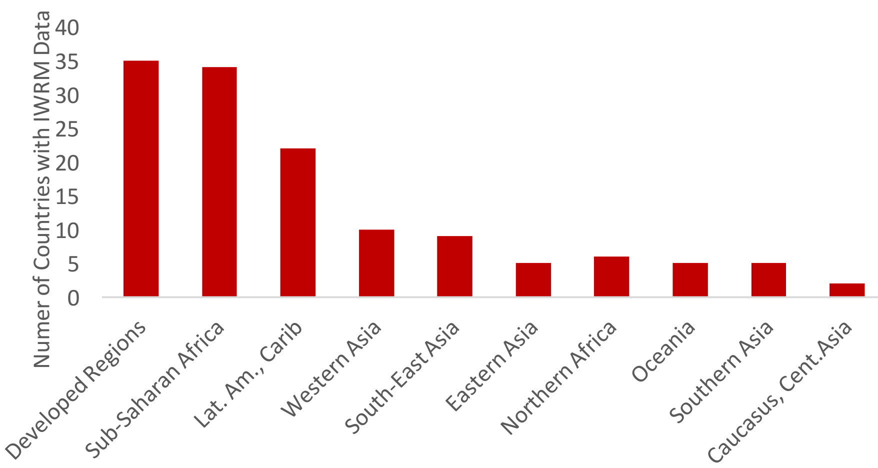
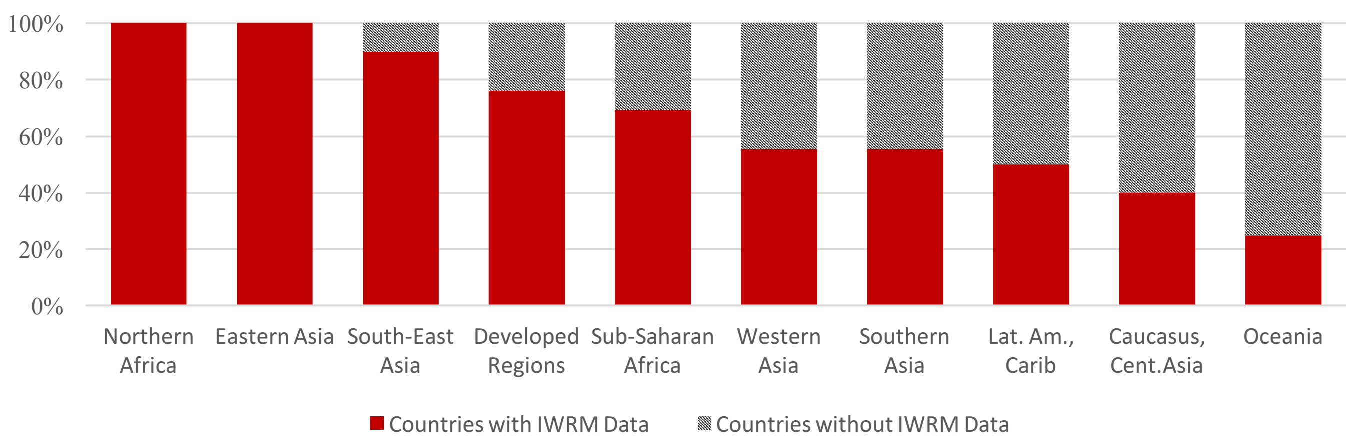


Table IV: *Regional IWRM*

Region	Average IWRM Score
Caucasus and Central Asia	20.0
Developed regions	68.6
Eastern Asia	52.5
Latin America and the Caribbean	42.9
Northern Africa	62.5
Oceania	32.0
South-East Asia	45.6
Southern Asia	46.0
Sub-Saharan Africa	47.0
Western Asia	41.2

Central Asia scores the lowest with 20 IWRM, but this is likely impart due to the limited amount of countries for which there is data in this region (2/5 countries (40%) (Figure 3). Less than half the countries reported data for Oceania, and Caucus and Central Asia, while approximately half the countries of Latin America and the Caribbean have reported data. The regional average is most accurate for Northern Africa and Eastern Asia, as this average has been calculated with data from all the countries in the region.

Figure 3. *Percent of countries with IWRM data [2011]*



2.3 Statistical Correlation Analysis

To begin statistical correlation analysis, the required data had to be download, organised and reformatted into workable form. The data can be downloaded in both excel or CSV formats from the UNDESA website[5] allowing for rapid and simple processing and graphing in Microsoft Excel. Maximum, minimum, mean and standard deviation values are determined per data set. With utilization of the newly acquired values, the entire range is normalized through equation 1 (OECD, 2008):

$$I_{qc}^{t} = \frac{x_{qc}^{t} - min_c(x_q^{t_0})}{max_c(x_q^{t_0}) - min_c(x_q^{t_0})} \quad 1)$$

Where x_{qc}^{t} is the value of indicator *q* for specific country *c* at time *t.* This normalization rescales the performance of each indicator from the units of the data set (i.e. proportion of population…), to a unitless performance where the worst performing nation scores 0, the best 1, while the rest is positioned somewhere in between. Afterwards a second normalisation method is applied to the original data set, namely the method of standardization or z-scores, equation 2 (OECD, 2008):

$$I_{qc}^{t} = \frac{x_{qc}^{t} - \overline{x_q^{t}}}{\sigma_q^{t}} \quad 2)$$

Where $\overline{x_q^{t}}$ is the average value of indicator *q* for the dataset and σ_q^{t} is the standard deviation. Standardization allows evaluation of probabilities, where all data sets are scattered around the mean of '0'. A more general global assessment can thus be made with regards to the overall indicator performance, drawing greater attention to a country when it is preforming significantly below or above average.

In terms of identifying relationships, the absolute performances as recorded in the original data set are initially plotted against each other to see if there is any obvious similarity between the two. This relation would be identifiable through the alignment of data points in a particular linear, exponential, logarithmic or polynomial trend. Afterwards the normalized performances are plotted against each other in similar fashion to see if the trend is better visible then. After the presence of a trend has visually been determined, the Pearson Product-Moment [6](R) is determined. This correlation coefficient ranges from -1 to 1, where -1 indicates an inverse correlation or anticorrelation, +1 a purely positive correlation and values closer to 0, a non-correlation. The Pearson Product-Moment is calculated in accordance to formula 3:

$$R_{xy} = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2}\sqrt{\sum_i (y_i - \bar{y})^2}} \quad 3)$$

Where x_i is value *i* in data set *x* and $\bar{x}$ is the mean of that dataset. The same respectively holds for *y.* In addition to the Pearson Product-Momentum, the Spearman's Rho, also known as the Spearman Rank-order (SPR), is determined. SPR is a parametric test that measures the strength of a correlation. +1 indicates a perfect positive while -1 indicates a perfect negative correlation, and is determined by formula 4:

$$r_{s(xy)} = 1 - \left[\frac{6\sum_i D_i^2}{N^3 - N}\right] \quad 4)$$

---

[5] https://unstats.un.org/sdgs/indicators/database/

[6] The Pearson Product-Momentum approximates the negative or positive nature and the strength of a correlation between two data sets.

Where D_i is the difference between values x_i and y_i, and N is the number of data pairs in the set. Together, these correlation coefficients serve as indicators for the statistical certainty on the relationship between the two datasets. The relating of the correlation coeficients to the linkage types as defined in section 1.3 allow for a more objective distinguishing of relations:

Constraining	when R_{xy} and $r_{s(xy)}$ are	< -0.7
Reinforcing	when R_{xy} and $r_{s(xy)}$ are	> 0.7

Unfortunately, interdependent and 'related' linkages cannot be identified through similar objective linkage type determination given the nature of the definition of those linkage relationships.

3 Results

The *Results* section of this paper is subdivided into two components. The first component (3.1) will present solely the results found in addressing the research question using national IWRM data. The second component (3.2) will present the results found in identifying all other possible intralinkages within SDG using the available, official data. The total study resulted in over 200 correlation graphs. Of these, the most significant possible correlation graphs were selected for further analysis in this report.

3.1 Integrated Water Resources Management Correlations

With a focus on the theme of *Water Management and Governance,* and in addressing the question: *Integrated Water Resources Management (IWRM) as an effective tool for SDG 6 implementation* - What is the correlation between countries ranking high/low in the implementation of IWRM (6.5.1) and their results on the other SDG 6 indicators?; consideration of the impacts of IWRM (6.5.1) on all the other indicators is given. Only those indicators for which there is published data, as summarized in the adapted Table III, are considered in the analysis.

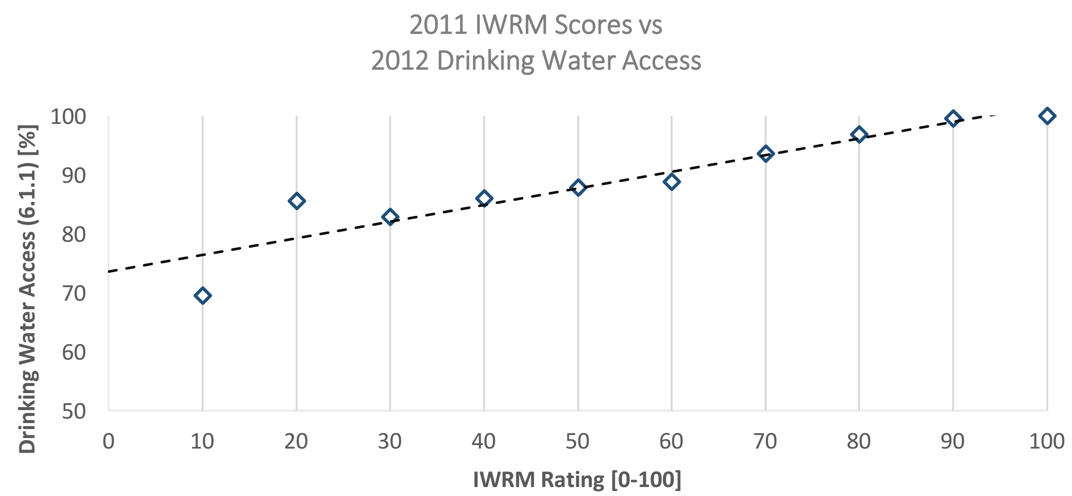
Table III (adapted): *Data Summary*

Ind.	Status	Temporal	Spatial	Notes
6.1.1	Complete	2000-2015	National	TNID[7]
6.2.1	Complete	2000-2015	National	TNID
6.4.2.	Partially complete	2002, 2007, 2012	National	Inconsistent
6.a.1	Only Developing Countries	2000-2014	National	TNID
6.b.1	Only Developing Regions	2014	Regional	TNID

3.1.1 IWRM (6.5.1) vs. Access to Drinkingwater (6.1.1)

The *average* drinking water access of all countries with the same IWRM score is compared to the average drinking water access of the countries with different scores (Figure 4). Classifying countries by IWRM score and calculating their groups drinking water average does away with regional particularities and allows for comparison purely objectively based on IWRM.

Figure 4. *6.5.1 vs. 6.1.1 by IWRM Rating for 128 countries*

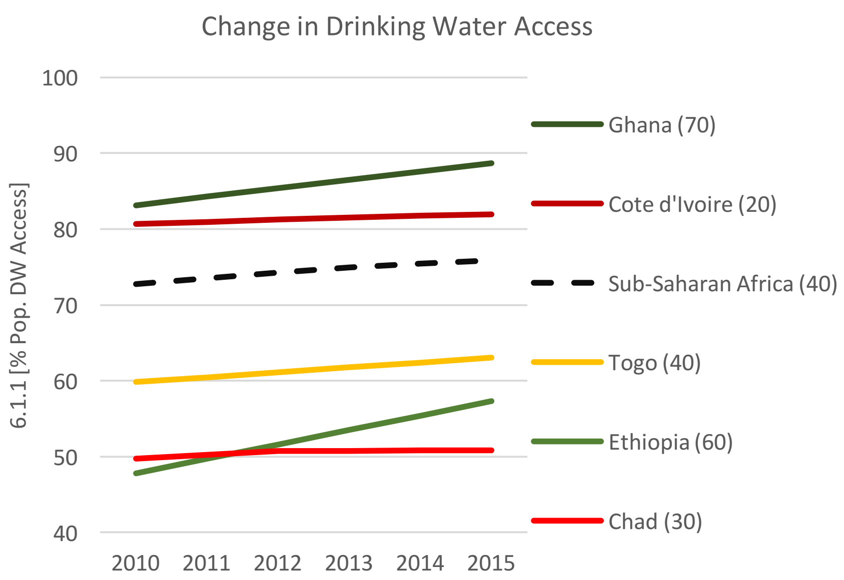


[7] TNID: Technically not the Indicator Data

When comparing this for 128 countries graphically in Figure 4, a noticeable, positive trend in increasing access to drinking water with increasing IWRM scores is observed. The Pearson Correlation Coefficient (R) of 0.93 for the averages in this trend suggests a strong, positive correlation. The statistically significant relationship is further reinforced by an Spearman Rank (SPR) of 0.98. A box-whisker plot for this trend is included in Appendix VI: *Additional Graphs* and shows the significant range for drinking water access average for each IWRM score.

Provided that high *performance* leaves little room for further *improvement*, it becomes difficult to compare performance on IWRM versus change in access to drinking water access in an equal way, globally[8]. Instead it may be of interest to consider improvements among nations from a regional perspective given that they often preform more similarly than with nations from entirely different regions. For Sub-Saharan Africa, a selection of five nations (Ghana, Ethiopia, Chad, Togo and Cote d'Ivoire) are compared in figure 5[9]. Here their performance on 6.1.1 over a period of 5 years (2010-2011) is presented. The number after the country in the legend indicates the country's IWRM scoring, and the black dashed line is the regional average performance.

Figure 5. *6.5.1 (2011) vs. change 6.1.1 (2010-2015). Sub-Saharan selection*



<u>Analysis</u>

Although the datasets in figure 11 are mostly linearly aligned, it is also noticeable that nations with particularly low IWRM (10) underperform the trend. Unfortunately/fortunately only two nations make up this class. The low sample size due to the few countries with this IWRM score, attaches a high uncertainty range to the calculated average access to drinking water. The same holds true for the other extreme end, of those scoring 100.

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[8] Investigation on correlation of IWRM with change in access was carried out but is not reported in this report. It showed that with improving IWRM the change in sanitation decreases. Because high IWRM is associated to a high performance in access to sanitation/drinking water, this evidences that it becomes more difficult to *improve* access as access is higher – a form of diminishing returns.

[9] As for Figure 13, one has to consider that this selection of nations was **not** made arbitrarily. There are many cases where nations with an extremely low IWRM, outperform those with much higher IWRM. This selection was made because it most clearly describes the trend of Figure 10, supports the hypothesis and appears most exemplary for the general pattern in the region.

In Figure 5, the high IWRM countries, Ghana (70) and Ethiopia (60), show much greater improvement than the low IWRM countries of Cote d'Ivoire (20) and Chad (30). This trend persists regardless of the different initial 6.1.1 scoring; Although Ethiopia, with a relatively low access to drinking water, does improve at a faster rate than Ghana, with higher initial access to drinking water (despite the similar IWRM score). It should also be mentioned that the IWRM survey for Ghana was only for 64% complete or 'relevant' for the selected 2011 questions.

3.1.2 IWRM (6.5.1) vs. Access to Sanitation (6.2.1)

When plotting the average proportion of population with access to sanitation per IWRM score (Figure 6), a similar, positive trend as with access to drinking water is observed. Where the minimum access to drinking water for IWRM score 10 was 69%, it is remarkable that for sanitation it is far lower, namely 20%. The nations with a score of 20 on IWRM also again outperform the trend on average. The R is 0.91 and the SPR is 1 which again indicate a significant correlation between this time IWRM and *averaged access to sanitation*. This is not surprising as there exists a certain correlation in data between the access to sanitation and the access to drinking water, which are in turn correlated to the Human Development Index (HDI) (UNEP, 2013).

Figure 6. *6.5.1 vs. 6.2.1 by IWRM Rating*

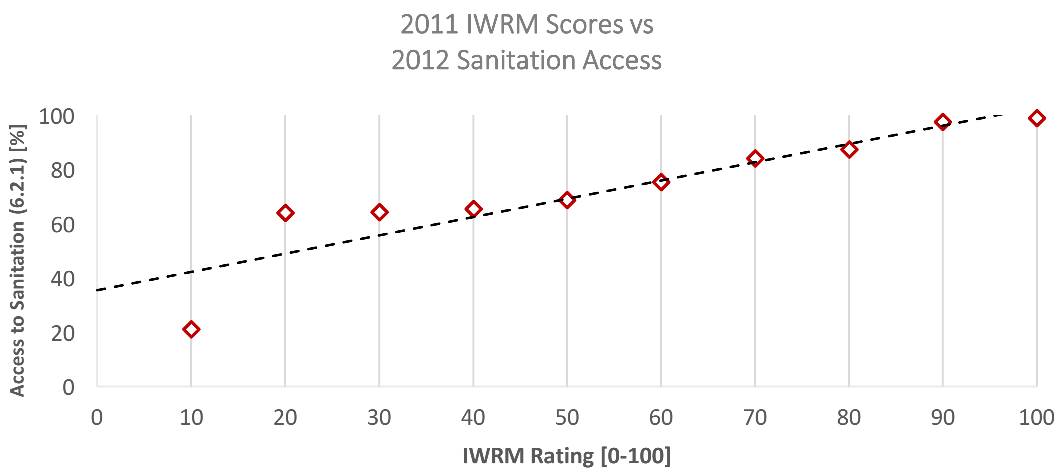
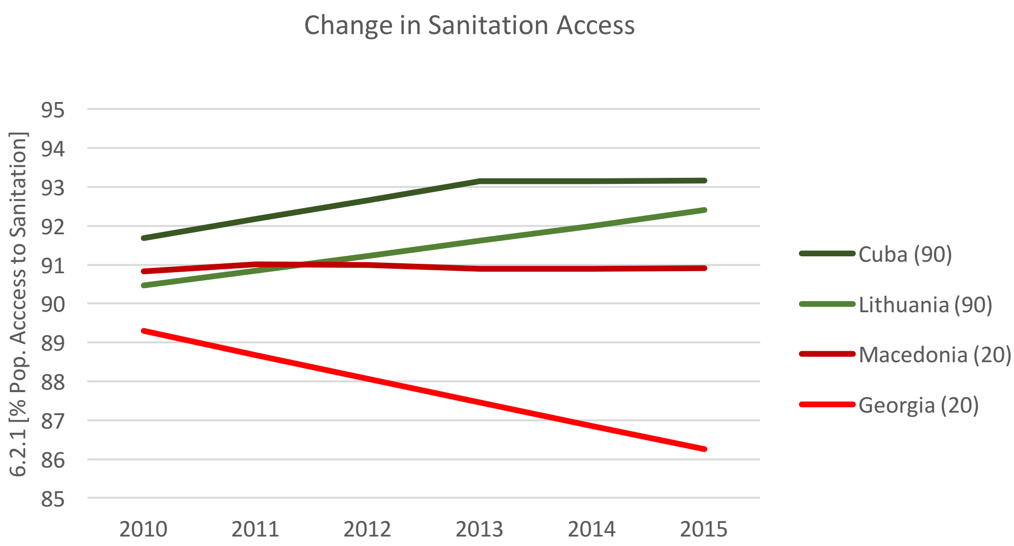


Figure 7 [10] shows the performance of four selected nations that have approximately equally high proportions of their populations with high access to sanitation (±90%).

Figure 7. *6.5.1 vs. 6.2.1, high sanitation access (~90%) nations.*



<u>Analysis</u>

Although the numbers for sanitation and drinking water are very different, the trends are very similar. In explaining the underperformance of IWRM 10 and outperformance of IWRM 20 in Figure 6, argument can be found in the degrees of freedom that the survey permits as well as the challenges in accurately scaling the survey answers into a [0-100] score. It is probable that in this case higher access countries belonging to the 20 IWRM score, would in actuality would belong to the 10 point IWRM score. Nations may have found incentive in not wanting to score lowest on IWRM and so have slightly overestimated their IWRM capacity. It is also probable that not all information was available for the individual answering the survey for these countries. By absence of information, a too optimistic estimation may have been made. With more countries of the 20 point IWRM group joining the 10 point IWRM group, both groups could shift closer to the trend line. Now that this correlation has been established, it may be interesting to explore the extent to which IWRM is still relevant even for nations with already a high access to sanitation. A Box-Whisker plot for the dataset is again provided in Appendix VI: *Additional Graphs,* showing the significant range and the quintiles for each point in the calculated trend.

From figure 7 it is clear that despite the low amount of 'room for improvement', nations with higher IWRM (90) still progress far better than those nations with low IWRM (20). Georgia is a very extreme example, as it is one of the few nations for which the access to sanitation is in decline. This is likely not solely due to a low IWRM score, but due to a combination of different factors. From figure 7 it so appears that IWRM is relevant on the improvement of access to sanitation regardless of the current proportion of access to sanitation.

[10] As with Figure 11, one has to consider that this selection of nations was **not** made arbitrarily. There are many cases where nations with an extremely low IWRM, outperform those with much higher IWRM (Covered in the '*Opposites'* appendix. This selection was made because it most clearly describes the trend of Figure 12, supports the hypothesis and appears most exemplary for the general pattern in the region.

3.1.3 IWRM (6.5.1) vs. Water Stress (6.4.2)

IWRM implies the efficient and sustainable utilization water resources. A reasonable hypothesis is that water stress (6.4.2) will decrease with increasing IWRM (6.5.1). As mentioned in the Data section of Methods and Techniques, water stress is measured as the freshwater withdrawal as proportion of renewable fresh water resources and is available for 31/212 (15%)[11] nations for at least two different years. This results in the number of countries in each IWRM ranking group being very limited. The impact of the likely inaccuracy in averaging water stress for so few nations in each IWRM class is unknown and should thus be kept in mind. Figure 8 shows a comparison of the number of countries with IWRM data in each IWRM class (red) and countries of that class that also have Water Stress data (green).

Figure 8. *Histogram IWRM & Water Stress vs IWRM data (2011)*

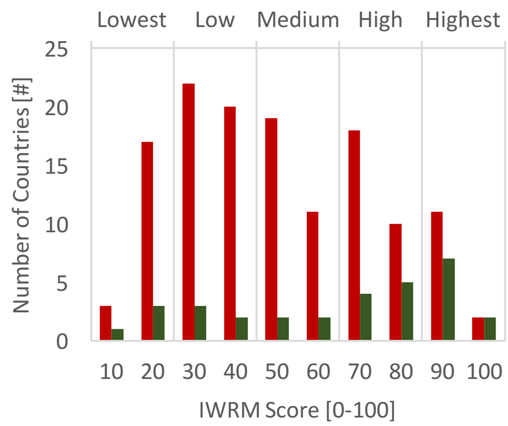
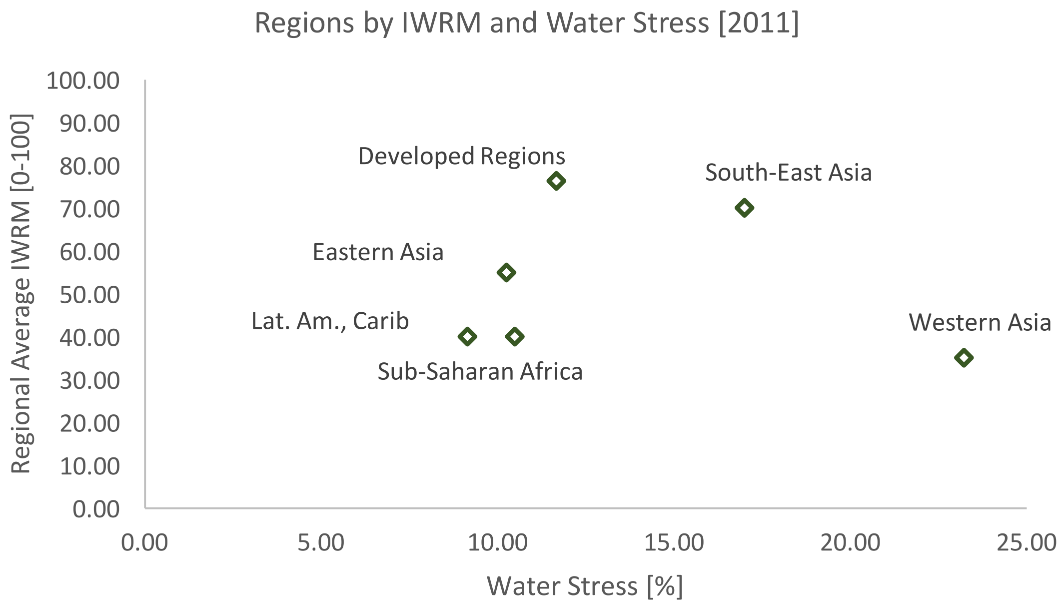


Figure 9 shows that regions with high IWRM do not necessarily have a low water stress. With the current region definition, most of the developed region lies within areas of relatively low water stress (Australia, with a relatively high water scarcity, being the example exception). There are, however regions with both far lower water stress as well as IWRM, like Sub-Saharan Africa. A significant variable that influences this is the water stress, or the amount of renewable water resources as captures natural water scarcity. The high water stress but low IWRM of Western Asia is surprising also, as one could hypothesize that the necessity for IWRM increases as water scarcity increases.

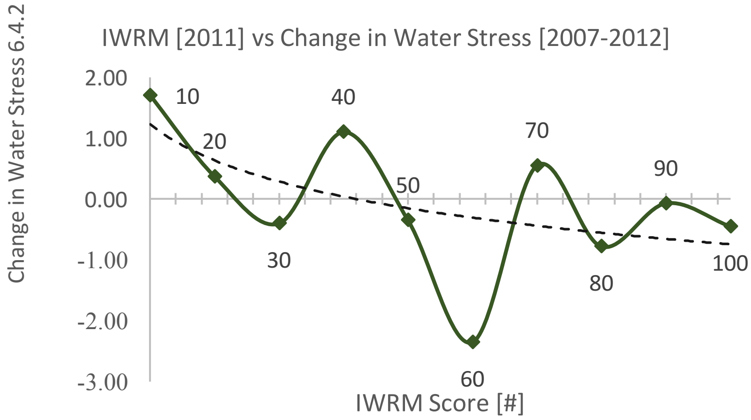
Figure 9. Regional 6.5.1 and 6.4.2 (2011)



[11] Antigua and Barbuda, Armenia, Australia, Azerbaijan, Belgium, Bosnia and Herzegovina, Brazil, Bulgaria, Canada, Cyprus, Czech Republic, Denmark, Dominica, Estonia, France, Georgia, Germany, Ireland, Japan, Kenya, Mexico, Mongolia, Netherlands, Philippines, Poland, Romania, Serbia, Spain, Sweden, Zwitzerland, and United Kingdom.

Figure 10 shows the change in water stress with different IWRM rated countries. The R and SPR are respectively -0.46 and -0.53, indicating a weak and negative, but not statistically significant correlation.

Figure 10. *Average 6.5.1 grouping vs 6.4.2*



Analysis

'Freshwater withdrawal as proportion of total renewable fresh water resources' has two components: 1) Fresh water withdrawal and 2) renewable fresh water resources. Because nations exert greater influence over their withdrawal as opposed to available renewable resources (more natural dependencies: River discharge, groundwater recharge and precipitation) it may be more interesting to only consider this first component. High IWRM would then theoretically lead to an increase in efficiency of water use and therefore decrease water withdrawal. At the same time, if due to growing demands freshwater withdrawal increases much faster than the reduction in withdrawal due to greater a greater efficiency, it may sometimes appear as if IWRM improvements come to no avail in reducing water stress as withdrawal (and thus water stress) goes up beyond what is saved through efficiency. Figure 9 does not show this. Instead it appears that water stress is not correlated to IWRM or that the influence of IWRM on water stress is masked by other (perhaps natural) variables that are much more significant.

In Figure 10, most remarkable would be the steep decline in average water stress for nations with a 60 point IWRM score. The 60 point score average *change in* water stress between 2007 and 2012 is calculated from the only two countries of 60 IWRM for which there is water stress data in those years, Cyprus and Estonia. These two nations have respectively reduced their proportion of 'freshwater withdrawal to freshwater resources' by 3.4% and 1.3%. The steep decline is thus likely by chance, where the limited amount of countries making up this group (2) coincidentally have both experienced a significant reduction water stress.

IWRM in theory has a strong influence in reducing the fresh water stress of nations by reducing the fresh water uptake through efficiency measures. Unfortunately this and other theories are difficult to test due to the limited amount of data available for 6.4.2.

IWRM (6.5.1) vs. 'Coordinated Government Spending' (6.a.1)

The relationship of IWRM with aligned Official Development Aid (ODA) spending[12], a proxy for water development coordination, is expected to be positive as well. In theory, where more funds are allocated to water projects the greater the IWRM will be. As expounded upon in the data section of the Methods and Techniques, however, the current data for 6.a.1 only indicates the water related ODA spending (ODAWS), and not the promised ratio of water related ODA spending to government water spending. ODAWS is also not corrected for a nations GDP/etc, therefore country size may be of greater influence on the ODAWS data than IWRM.

Figure 11 compares the number of countries in each IWRM grouping (red) with the number of countries in that grouping that have ODAW data (orange). Unfortunately, there is no data for the 90 and 100 scoring IWRM countries on ODAWS, while only two countries of the 80 IWRM class have data. It can thus already be concluded that few of the countries receiving ODAWS have high IWRM, and the vast majority of ODAW nations score 30 on the 0-100 IWRM scale.

Figure 11. *Histogram IWRM & ODA data (2011)*

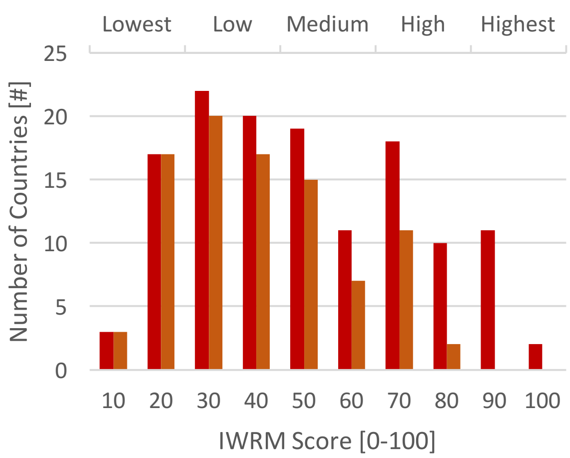
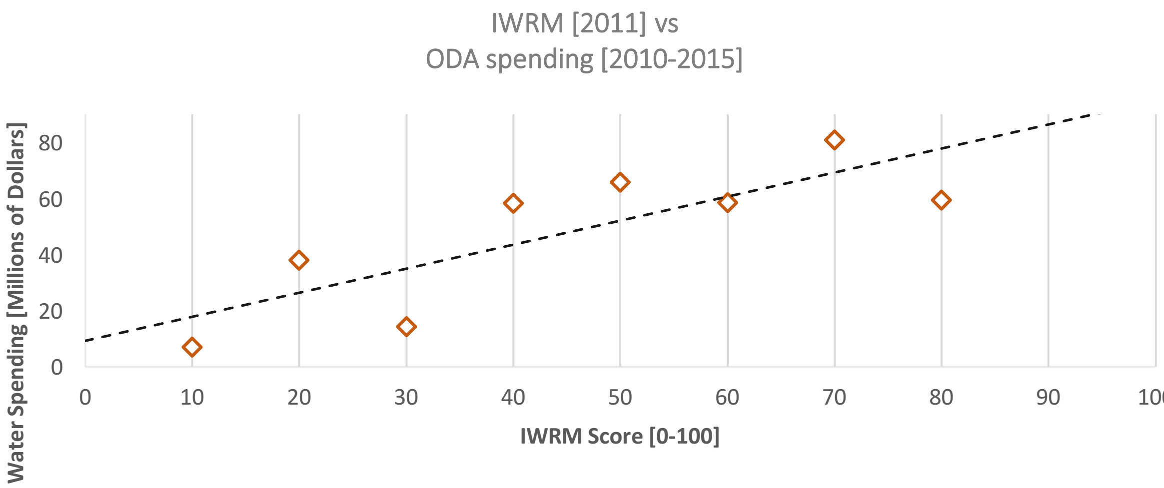


Figure 12 shows per 2011 IWRM grouping and per region for the *absolute amount* and *change* ODAWS in the individual years of 2009 to 2015. Though recognizing that ODAWS should be the independent variable, IWRM will still be kept on the x-axis of Figure 19 to remain consistent in methodology. The associated R and SPR are 0.81 and 0.84 respectively, indicating a positive, statistically significant correlation. The initial hypothesis is confirmed as greater funds are associated with greater IWRM.

Figure 12. *Average IWRM (6.5.1) grouping vs ODA (6.a.1)*



12 ODA, or Official Development Assistance, is an indicator for international aid flow. It was a term first introduced by the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD) and is defined as: The flows of official financing administered with the promotion of the economic development and welfare of developing countries as the main objective, and which are concessional in character with a grant element of at least 25 percent (using a fixed 10 percent rate of discount). By convention, ODA flows comprise contributions of donor government agencies, at all levels, to developing countries ("bilateral ODA") and to multilateral institutions. ODA receipts comprise disbursements by bilateral donors and multilateral institutions. - OECD, Glossary of Statistical Terms

Analysis

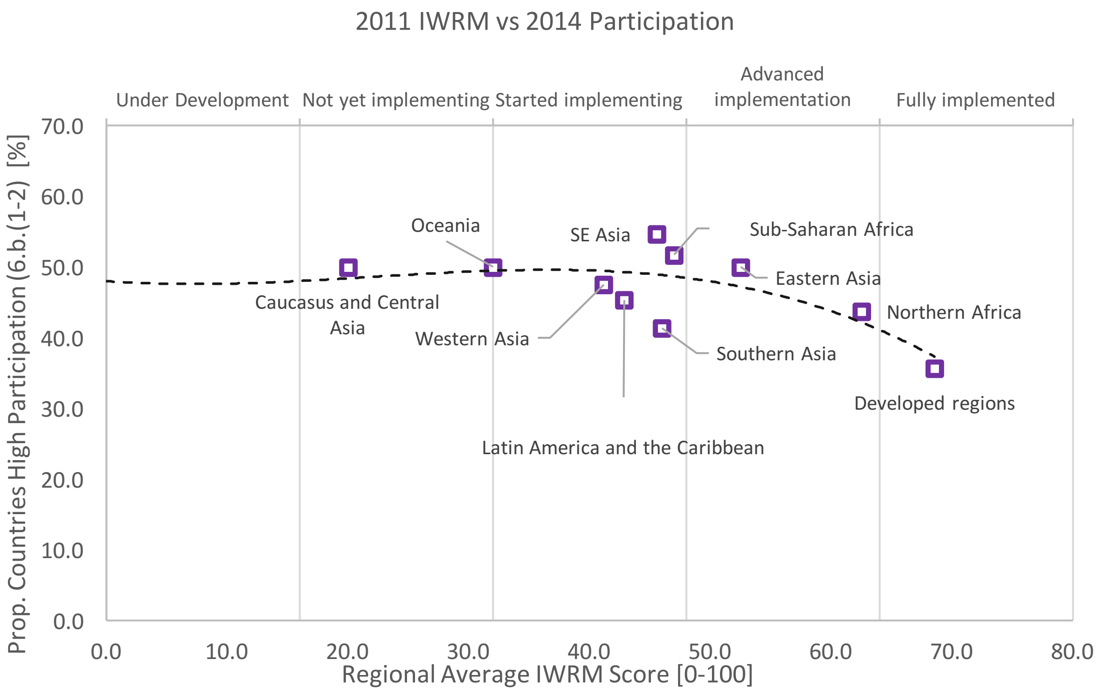
The data for 6.a.1 for this investigation is the amount of finances by ODAWS - which relates to the fourth component of the IWRM survey, Financing: Financing and budgeting made available and used for water resources development and management. With an increase in ODAWS, one would by definition expect an increase in IWRM, as Figure 19 shows. At the same time, countries with lowest IWRM would theoretically attract the greatest ODAWS as they are in greatest need, yet the data does not show this. The possible time-lag – the time before a change in IWRM due to an increase or decrease or absolute amount of ODAWS can be noticed – should be explored in more depth. Nevertheless, statistically the groups of nations with higher IWRM show greater cumulative ODAWS.

IWRM (6.5.1) vs. Participation (6.b.1)

To match the spatial resolution of the participation dataset (6.b.1) a calculated, regional IWRM will be used in this comparison. The indicator for participation has been determined using a combination of both the proportion of countries with (1) a high level of users/communities participating in planning programs and with (2) clearly defined *procedures in law or policy* for participation by service users/communities. The best correlation with IWRM could be found by taking the total urban and rural population together, as well as the aggregating the distinguishing data sets of both sanitary and water management programs for participation.

Figure 13 shows the trend between the regional average IWRM and the proportion of countries with high participation. It is remarkable that despite participation being one of the components used in the assessment of IWRM, participation appears to mildly decrease for the higher values of IWRM. The Developed Region has the highest IWRM of almost 70 on average, yet it also has the lowest participation, a score of approximately 36%. Despite the high amount of countries with clearly defined laws and policies on participation (71%), there is very little high level actual engagement of communities (0%). The overall, average score is therefore 36%.

Figure 13. *6.5.1 vs 6.b.1 Composite*

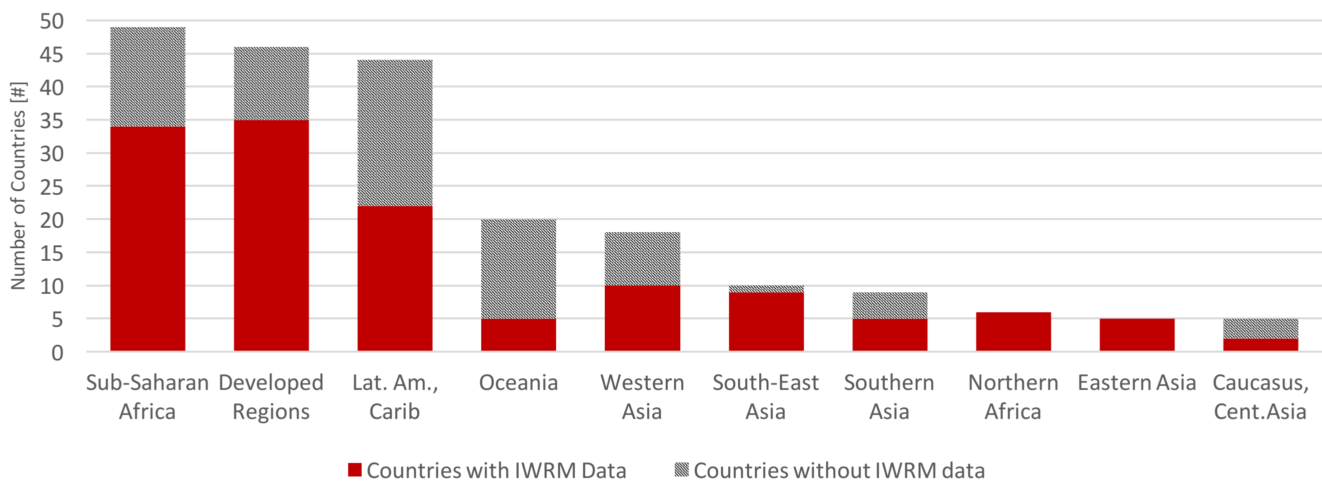


The R value of -0.58 indicates a moderate, negative correlation where high IWRM scores tend to associate with low participation and countries with relatively low IWRM, have relatively high participation. The SPR is -0.4, which means that the correlation would normally not be considered statistically significant.

Analysis

Caucus and Central Asia scores by far the lowest on IWRM but has only 1/2 countries (50%) with a high level of public engagement. Considering this calculation is done for only the 2/5 countries (40%) for which there is data in the region, one has to remains skeptical on representatively of the average value (Figure 14). A discussion on averaging is presented in the *and Conclusion* chapter (4) of this report. 50% proportion of countries with high participation in the region nevertheless gives Caucus and Central Asia a shared 3rd place on the global ranking on regional participation.

Figure 14. *Regional IWRM data completion (2011)*



To conclude, the very small sample sizes for 7/10 regions (70%) are expected to contribute significantly to inaccuracies in averaging and therefore also the trend, possibly explaining the positioning of some regions as well as the unexpected nature of the trend (Figure 14 and Figure 2 and 3 on page 13).

3.1 SDG 6 Correlation Graphs

In addition to the guiding research question on the correlation of IWRM with the other SDG indicators, a part of this investigation also explores some of the other intralinkages within SDG 6, but this time using exclusively the data that available and published on the data portal.

3.2.1 IWRM (6.5.1) vs. Access to Drinking Water (6.1.1)

The proposed research question: '*What is the correlation between countries ranking high/low in the implementation of Integrated Water Resources Management on the other SDG 6 indicators?*' concerns the influence of indicator 6.5.1 on all the others, and was explored in the previous subsection. In that section, an exclusive *national dataset* for IWRM was used that is not published on the data portal. This sub-section 3.2.1 explores intralinkages with IWRM using only the published data (regional IWRM) and so the analysis was carried forth using only regional values provided or calculated for the other indicators also.

Figure 15 shows the performance of indicator 6.1.1 *Access to Drinking Water* with the performance of 6.5.1. for 2015. The general performance of regions with few high IWRM countries, also score low on 6.1.1, while regions that have a higher amount of countries with high IWRM, score better on 6.1.1. Normalisation emphasizes this difference by construing the axis values (Figure 16). The R for the normalized data is 0.7 and SPR is also 0.7. When not including the three outliers (4,5 and 9), they are 0.99 and 0.96 respectively. The correlation coefficients suggest that there is a significant correlation between a regions' scoring on IWRM and performance on access to drinking water. Oceania is rated to be the worst performer on both IWRM (0% of the countries with high IWRM) and safe drinking water access (55.7% of the population) and therefore forms the origin of Figure 16.

Figure 15. IWRM *(6.5.1) vs. DW Access (6.1.1)*

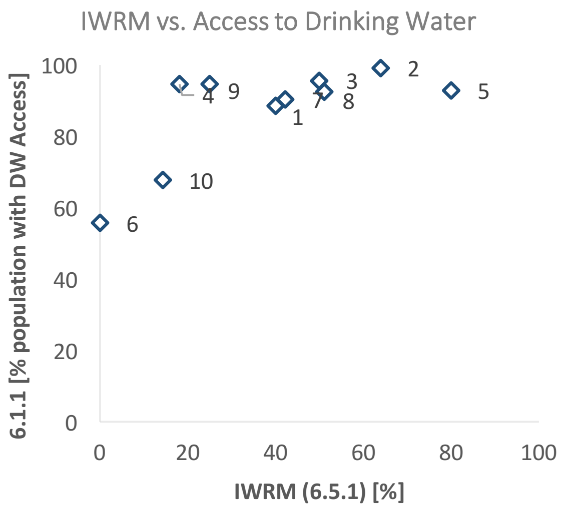
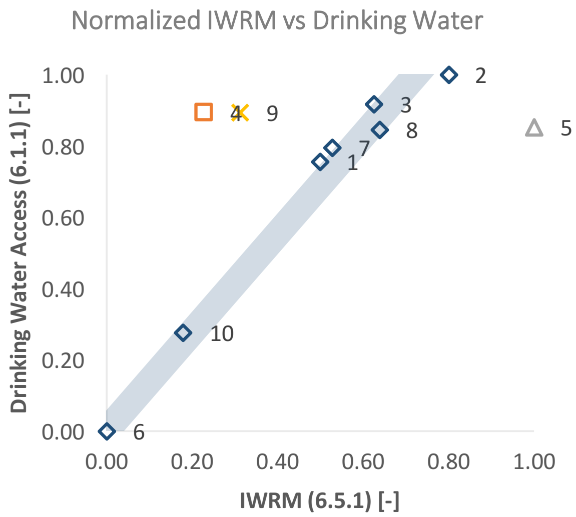


Figure 16. IWRM *(6.5.1) vs. DW Access (6.1.1) normalized.*

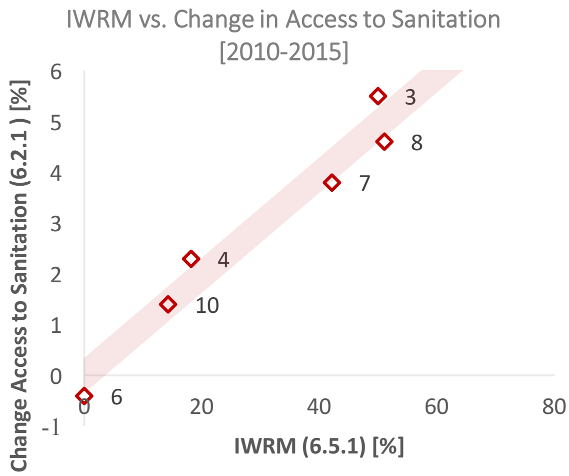


LEGEND			
1	Caucasus and Central Asia	**6**	Oceania
2	Developed regions	**7**	South-Eastern Asia
3	Eastern Asia	**8**	Southern Asia
4 □	Latin American and Carib.	**9** x	Western Asia
5 Δ	Northern Africa	**10**	Sub-Saharan Africa

3.2.2 IWRM (6.5.1) vs. Access to Sanitation (6.2.1)

IWRM and access to sanitation how a clear trend when excluding nations that have little room for improvement. Figure 17 is created not including nations with more than >90% access, which are considered to have passed the threshold of significant room for improvement - Caucus and Central Asia (1), Developed Regions (2), Northern Africa (5) and Western Asia (9)). The figure shows the improvement on 6.2.1 as the *additional* percent of population with access to safe sanitation since 2010 to 2015. There are no significant outliers and thus produces a R and SPR of 0.98 and 0.94 respectively. Countries with the higher IWRM show greater improvement on change in access to sanitation. Oceania (6) is the only region with no high level IWRM nations, and shows a decrease in access to sanitation since 2010.

Figure 17. *IWRM (6.5.1) vs. change Access Sanitation (6.2.1)*



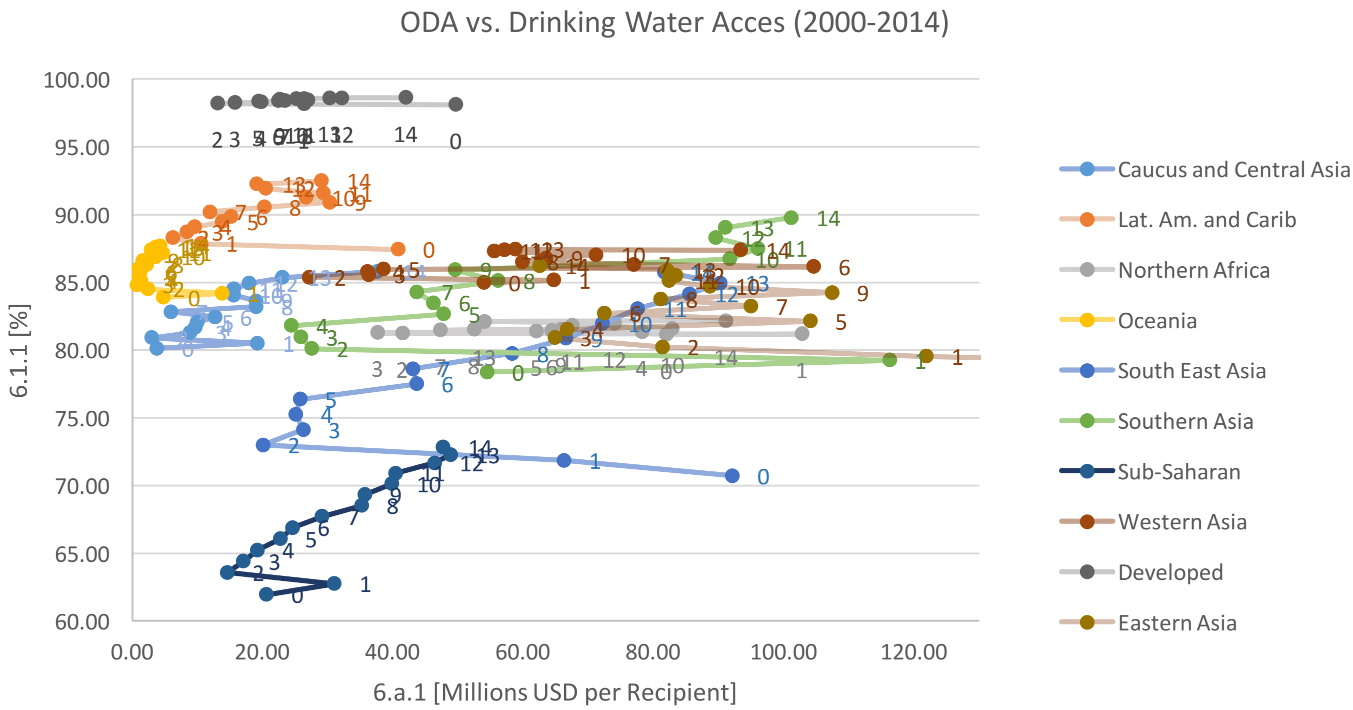
LEGEND	
3	Eastern Asia
4	Latin American and Carib.
6	Oceania
7	South-Eastern Asia
8	Southern Asia
10	Sub-Saharan Africa

3.2.3 ODA Spending (6.a.1) vs. Drinking Water Access (6.1.1)

6.a.1 is identified as the amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan. As mentioned in the Methods and Techniques, however, the published data is incomplete, so only the amount of water related ODA spending is available for analysis.

Figure 18 shows the trends between ODA water spending (6.a.1.) and the proportion of the population with drinking water access. Because there is very little actual decline in population with access to safe drinking water (except Oceania), one may assume that time progresses yearly in proportion with increasing increments of access.

Figure 18. ODA (*6.a.1) vs. DW Access (6.1.1)*



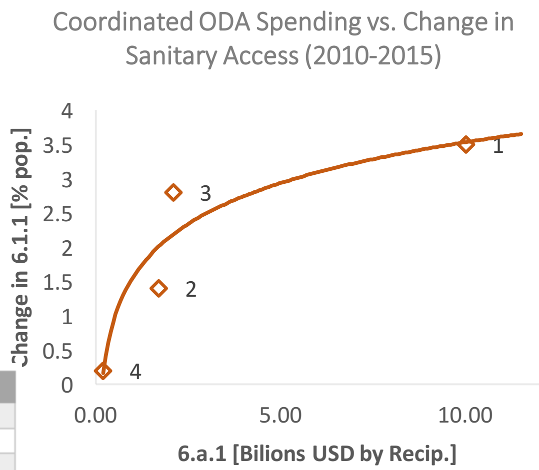
Analysis

A typical increasing trend can be observed for all of the regions. The regions that start higher on the y-axis (Developed regions), with a higher initial population already with access to safe drinking water, do not improve as much with increased coordinated spending than nations beginning lower on the y-axis (Sub-Saharan Africa). Since consideration is only given to the hard, ODA cash flow into the water sector and not ‘coordinated spending’, a form of diminishing returns can be identified in the correlation with ODA to drinking water access. That is to say that with the same amount of financial resources put into the sector, the effective improvement becomes less and less as access increases. The figure shows the yearly progression where the label numbers indicate the year in 2000 (i.e. 10 is 2010).

3.2.4 ODA Spending (6.a.1) vs. Acces to Sanitation (6.2.1)

When plotting the ODA (6.a.1) data against the change in **access to sanitation** (6.2.1) over the past 5 years for the GLAAS regions, a logarithmic, or at least positive, trend is observed (Figure 19). The sample size of four GLAAS regions is too small to determine R and SPR. The trend is largely determined by the position of the value for Developing regions (1), who poses a spending sum that is fourfold of the next highest (least developed countries) to water projects. Given the lack of data points for Figure 19, it may again be of greater interest to look at this trend for the calculated regional data instead (Figure 20).

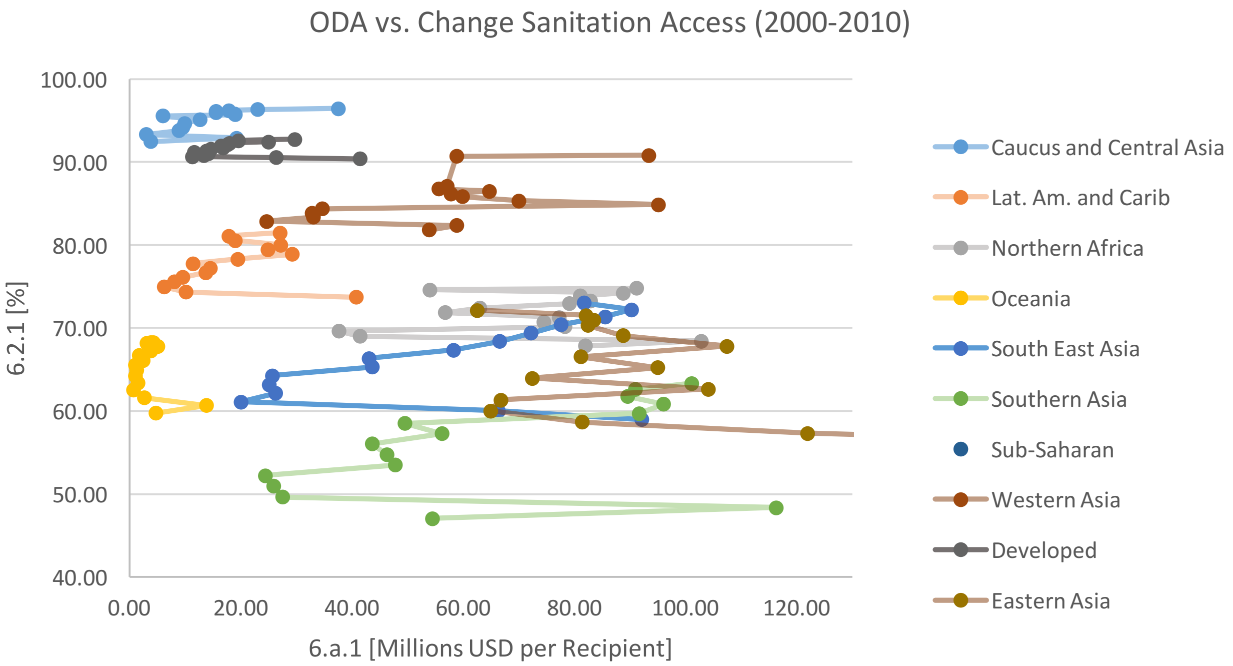
Figure 19. *6.a.1 vs change in 6.1.1*



LEGEND	
1	Developing regions
2	Landlocked developing countries
3	Least developed countries
4	Small island developing States

Positive trends are still observed for regional ODA spending (6.a.1) and regional access to sanitation (6.2.1) as illustrated in Figure 5. The year numbers have been excluded for clarity, and so it can be seen that the figure shows similar trends as displayed in Figure 18 (page 26).

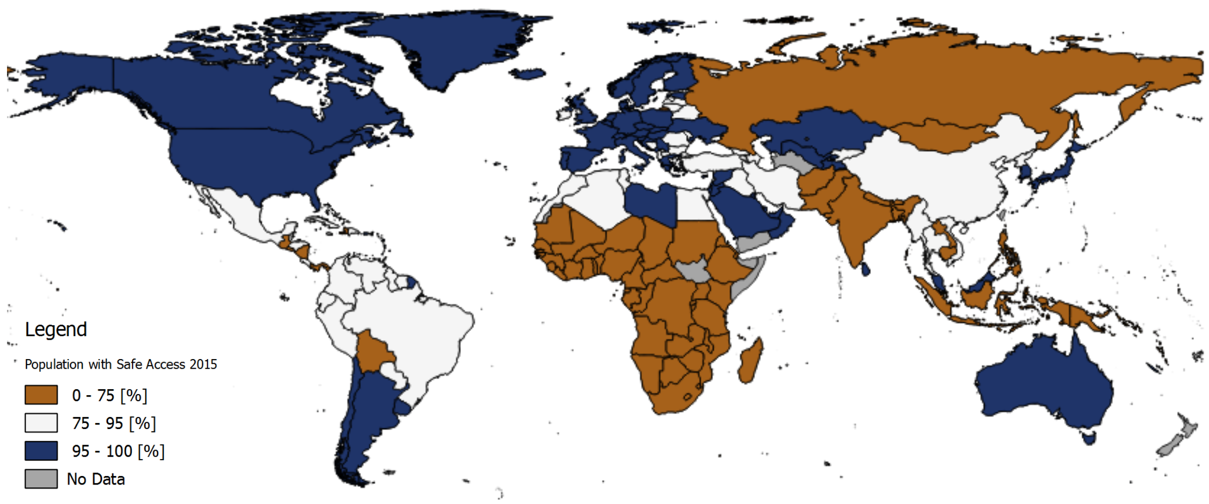
Figure 20. *6.a.1 vs. 6.2.1*



Analysis

Noteworthy again is Oceania, which, due to the little variation in ODA spending, reveals how other forms of spending or other variables may influence the access to sanitation and drinking water. Other variables such as government spending, participation, law, regulation, policy, climatic fluctuations, and/or demographic and social developments, result in the irregular curve for Oceania but may also be at play on the other regions. Their exceptionality has to be recognized though given the results of the previous section (Figure 3). These revealed that Oceania is the only region in which there has been a decrease in access to safe sanitation over the past 5 years. Appendix II *Oceania as an* Outlier gives more explanation as to why Oceania is so frequently an outlier to the trends with other regions. Again, Northern Africa shows little change, while steepest growth is noticeable in regions with significant room for improvement: Sub-Saharan Africa, Southern Asia, and South East Asia (Map 2).

Map 2. *6.2.1 Access to Safe Sanitation Facilities 2015*

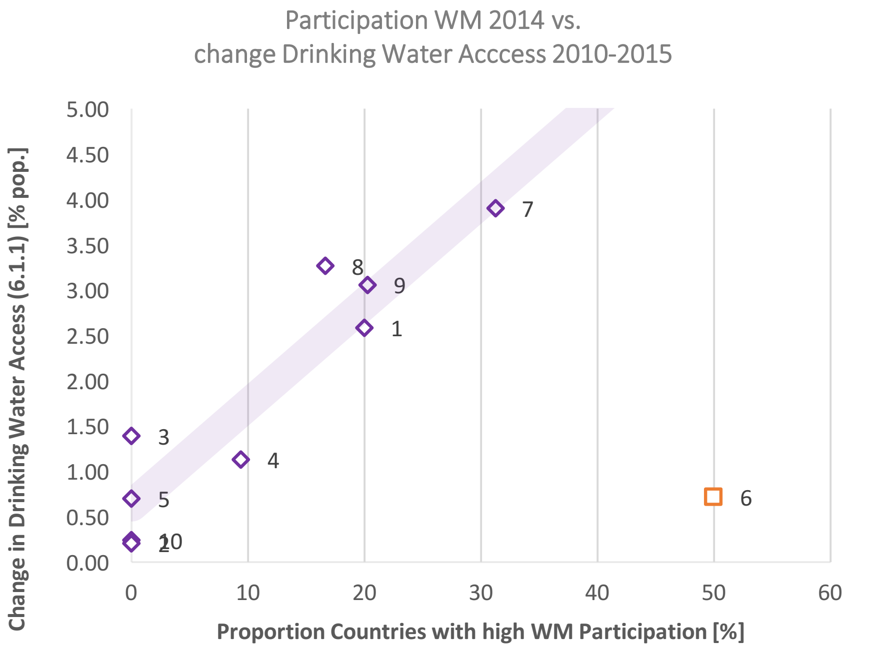


The trends do not appear to change significantly for (absolute) higher ODA spending than that for lower. The overall conclusion that can be drawn is that 6.1.1 and 6.2.1 may improve at relatively constant proportions to each other for most regions depending on how much room for improvement there is left. The improvement on 6.1.1 is greater than for 6.2.1, which is in accordance to historical trends where ODA spending has typically been more concentrated on drinking water efforts.

3.2.5 Participation in WM Programmes (6.b.1) and Access to Drinking Water (6.1.1)

The correlation for change in drinking water access (6.1.1) over 2010-2015 with participation in water management programs is weak but positive. The scatter around the trend line is high resulting in a low R of 0.46 and SPR 0.64. When excluding Oceania, a significant outlier, these improve to 0.88 and 0.9 respectively.

Figure 21. *6.b.1 vs. change 6.1.1*



LEGEND	
1	Caucasus and Central Asia
2	Developed regions
3	Eastern Asia
4	Latin American and Carib.
5	Northern Africa
6	Oceania
7	South-Eastern Asia
8	Southern Asia
9	Western Asia
10	Sub-Saharan Africa

<u>Analysis</u>

Regions with similar proportion of countries with high participation show a high deviation in change in drinking water access to each other. Regions 1, 9, and 8 have approximately 20% of their countries with high community involvement but still show a difference in improvement of access of approximately 1% amongst each other. A similar pattern is observable for regions with no participation (3, 5, 2 and 10), where the difference approaches 1.5% of population between the regions. Nevertheless, as a general trend, regions with a higher amount community participation show a greater change in drinking water access than those with low participation. Oceania’s distant position can again be explained by the arguments provided in Appendix II *Oceania as an Outlier.*

While a low change in drinking water access could be interpreted as bad performance for most regions, consideration must be given to those regions that are approaching 100% access to drinking water. These regions, the developed region foremost, will show a low improvement because they are approaching, have achieved or surpassed the technical feasibility threshold of 97% for Access to Drinking Water (Sachs et al. 2016).

4 Discussion

There are numerous *nota bene's* that have to be addressed concerning the identification of causal relationships between the indicators of SDG 6. They pertain predominantly to the issues regarding the data, but also the methodology has important side notes. After these discussion points, a general conclusion and some recommendations are presented. The discussion section of this paper is therefore subdivided into those respective four points.

4.1 The Data

While a lack of data availability and completeness is one encounter that troubled this investigation, it was expected that indicator ambiguity would be another. The importance of *Integrated Water Resources Management* and the *international cooperation and capacity building support* are essential in the description and achievement of global water security, but it was assumed that the nature of their definition would make quantified comparison difficult. IWMR is highly multidimensional, hence the UNEP-DHI partnership has defined a broad selection of component indicators that are evaluated for in determining general IWRM. Though these components do good justice to the overall complexity of IWRM, their multitude in defining IWRM would theoretically complicate comparison. The 'equifinality', where different sets of combinations of components may lead to the same result, would pose issues as each of the components influences each of the different water sectors in very different ways. Surprisingly, insight into the national, 2012 survey results revealed that most nations actually preformed very similarly on the different components. In conclusion, there was observed a relative homogeneity within the data, where there are no significant outliers in the performance of the nations between their own scores on different IWRM components. The complexity of definition was not an issue for at least the 2011 IWRM dataset, but might be so for the coming 2017 dataset.

The expected 'equifinality' issues of IWRM (6.5.1) are actually present in dataset on ODA (6.a.1). Where cooperation is currently measured as the amount of aligned ODA spending, it does not specify the focus of the cooperation which can again take a myriad of different forms. Although the current data does not encompass coordination, it is a foreseeable issue once the data set does become available. Even so, the data currently is presented in millions of dollars ODA for water per recipient, and gives no indication of possible other forms of spending in/on the water sector. The broad definition of the term does work to benefit the comparison with other broadly defined indicators such as 6.5.1, for example.

4.1.1 Data Quality

The quality of the datasets and their acquisition methods also come with many discussion points. One can question whether requesting countries to grade their own IWRM is an accurate and objective method of assessing general IWRM performance. The IWRM 2012 data also does not specify whether the policies, plans, etc.. have to be operation or not, or to what degree an amount of financing is 'adequate' or 'necessary'. Similarly, the value and implication of assessing 'coordinated government spending (6.a.1.) and its impacts also raises questions. Every indicator has its own peculiarities and points of critique. Given that data assessment is not the focus of this study, these will not be treated here. Instead the implication of general flaws that are present in many of the data sets will now be discussed.

4.1.2 National vs. Regional Resolution

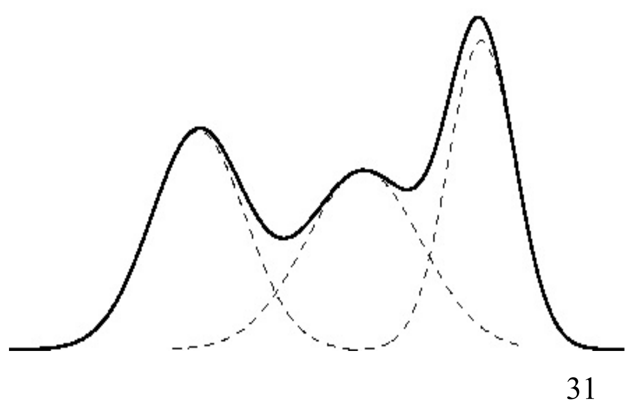
As introduced in the data section of the *Methods and Techniques*, there are inconsistencies among the data sets with regards to spatial and temporal resolutions. While selecting for specific years may overcome some of the temporal inconsistencies, selecting for different spatial resolutions is often hardly possible. The finest possible resolution of a correlation analysis or comparison is equal to the resolution of the coarsest dataset. For this reason, national datasets were averaged to regional values. The result can be misleading not only in the sense that the entire region is represented by only the (few) countries for which there was data in that data set, but also in the values. For example, in some instances the regional average access to drinking water was calculated. Where country 'A' may have 20/40 million people with access (50%) country 'B' could have 9/10 million (90%). The regional average access is presented as (50+90)/2 = 70%, while in actuality, the regional access ie 9/10 +20/40 = 29/50 million people with access, or 58% (difference of 12%). When a regional calculated average was used instead of the provided average, it is mentioned, and it was specified that this is the average of national scores. The reason for using a calculated average was to exclude countries that did not have data in the other dataset. In example, when only 15/20 countries have data for indicator 'A', a regional average for indicator 'B' was calculated using only the indicator 'B' data for those same 15 countries. The implication of this is that actual 'access' of the region is no longer properly reflected, but instead replaced by a 'performance' grade for the region based off of the country scores.

Furthermore, for most data correlations plotting 212 national data points for both indicators against each other in whatever way, would reveal no trend. Therefore sometimes the choice was made to determine regional averages even if both datasets provided data at national scale.

4.1.2 Regional Data

Regional data makes correlations easier to determine and understand, but it also has pitfalls. Distinct regional diversity is lost and is no retraceable. As an example, Latin America & the Caribbean, as the name implies, consists of at least two distinctly separate sub-regions. The Caribbean faces entirely different challenges than the rest as fresh water is far less abundant and population settlements are far more concentrated. As the statistical distribution, by this theory, no longer tends to the presumed normal distribution but to a bimodal distribution, and the regional average value loses its representativity. Assuming also the unique performance of a third sub-region, arid Central America, the distribution of the region would become multimodal, as illustrated in figure 22. The top of each apex would represent the 'average country' of each sub region. When taking a total, regional average, a value is acquired somewhere in the middle that in the end describes only a few countries of the total region, but none typical of the entire or a single sub-region. Arguably, together with the developed region, Latin America & the Caribbean shows the greatest internal diversity of all the regions, making the validity of its regional average values questionable. Even though the national scale IWRM data is not published, this theory can still somewhat be tested by taking the differences in average Water Stress between the sub-regions. The regional average is 9.8%; the Caribbean: 23%, Central America: 4.2%; and South America 1.5% freshwater withdrawal of available freshwater resources. The regional 9.8% significantly overestimates freshwater withdrawal for all of South America, while it significantly underestimates water withdrawal for the Caribbean. The 'developed region' is a second region with significant internal

Figure 22. *Multi-modal distribution*



diversity, yet it displays no erratic positioning on the trend charts likely because of it’s relative, equally high performance on most indicators.

4.1.3 Missing Data

Inaccuracies in averaging due to the (lack of) data for some countries may be most easily blamed in explaining the deviation of certain regions from the determined trend..In the case of Western Asia, for example, there is IWRM data for only 5/12 (42%) of the countries (Appendix III: *Data Availability Information*). One can then question whether this produces a skewed average due to the likely MNAR data - **m**issing **n**ot **a**t **r**andom data type, where the countries that have not filled in the survey belong to a certain category of countries that share a common, relevant trait that may explain this absence of data. It is possible, for example, that the political instability of certain countries contributes to the incompleteness of the data, and that those same countries would likely score lower on their access to safe drinking water target given that state of instability. At the same time, the institutions, laws and policies and management instruments as installed prior to the conflict (3/4 IWRM components), might not have changed as the political preoccupation lies with the de-escalation of internal conflict. Their functioning would, however, suffer, but the functioning or performance of the IWRM components is not explicitly questioned, only their implementation or setting in place. A presumed lower proportion of access to drinking water and an equal or higher IWRM rating for the missing 58% of the countries, would shift Western Asia closer towards the trend line in the relation with IWRM and drinking water.

4.1.3 Room for Improvement

Wrong impressions may also be created when plotting the change in one indicator against the performance of another. For nations that are close to achieving the feasibility threshold of certain indicators, it becomes incredibly difficult to improve. An example is Singapore, who has shown no improvement in access to sanitation since 2010. The reason for this is is because Singapore has in 2010 already achieved 100% access. Distinguishing between countrieso regions that improve poorly and countries or regions that simply do not have room to improve anymore is done by excluding those high performing nations from the correlation analysis. Nevertheless, it should be kept in mind that it is not a threshold processes, but a gradual processes where Irving simply becomes more difficult as one comes closer the achieving the goal.

4.1 The Methodology

The greatest point of attention for the reader is with regards to the methodology. It is necessary to recognize the subjectivity that is at play in establishing linkages and causal relationships based off of correlation investigation. Secondly, one has to remain sceptical on the suitability of global approach for many of these correlations.

4.2.1 Subjectivity

There exists great temptation in trying to identify trends that are in all likelihood not trends, or in discarding apparent non-trends that actual contain a lot of information. While statistical correlation determination is objective, the analysis and determination of causality is largely subjective and has many pitfalls. As emphasized before, it is essential therefore that both quantitative assessment and qualitative assessment are carried out thoroughly and together. This reduces the likelihood in coming to incorrect conclusions, but cannot guarantee 100% accurate analysis either. Unfortunately, the precise implication of this subjectivity can only be pinpointed once the study is carried out by a second or third individual.

4.2.2 Global Diversity

Apart from the methodology allowing for a large degree of subjective interpretation, it also does not account for the issues of global diversity. Despite the globalized effort on Agenda 2030, one has to recognize distinct global diversity in comparing, analysing and establishing correlations in data among the region. Ideally, when analysing for trends, one would try to keep other variables that are of influence on your dependant variable, as constant as possible. That way one isolates the influence of only the variable of interest. By varying the independent variable and measuring the effect thereof on the dependant variable, a relationship can be parametrized and formulated. Unfortunately, the indicators of SDG 6 are subject to an incredibly many external variables that cannot be all accounted for, let alone kept constant because water and water management are so integrally intertwined with society and many of its unquantifiable, social parameters. In addition to that, the regions, countries (and even administrative subdivisions below that), do not all obey the same social-hydrological water rules, as cultures, climates, economics and politics, create unique cases that respond uniquely different to similar scenario's. That is to say that the effect of one indicator on another can be completely different for two climatically similar countries, but of completely different cultures, or the other way around. A more reasonable, but much more intensive, approach would be to isolate those countries belonging to similar cultural, climatic, economic and political environments and compare them amongst themselves, which has been partially attempted in Figure 12. One can then more fairly assume that the many other water influencing parameters are constant and so evaluate what the effects of a selected indicator performance is on another. These groupings would be far smaller than the current groupings. To give an example of the scale of this new grouping, consider the following: Scandinavia, Pacific Islands, Central America, Mediterranean Europe, Balkan Europe, Tropical/arid Sub-Saharan West Africa, etc.

4.1.2 Assessing Causality

The qualitative assessment in this methodology is very limited. Where many of the data reports by JMP and GLAAS provide a good, overview and summary of the data that has been gathered, none of them provide a regional, in-depth analysis that explain for the different trends amongst different regions. The World Bank has relatively precise regional summaries, but that information pertains mostly to the economic status or an overview of the relations that the World Bank shares with that region. The World Water Development Reports provide greatest insight of regional variations, but do so for an inconsistent, incomparable set of themes for the different years. Many of the explanations for outliers that could not be explained through these reports, therefore rest on common knowledge and general knowledge on current state of water affairs and plausibility of the relationship given the data.

The biggest concerns with regards to the conclusions drawn on the influence of IWRM (6.5.1) on the other indicators lies in the assessment of causality. The multifaceted definition of IWRM captures explicitly (i.e. component 4: Financing and current 6.a.1) or implicitly (i.e. component 1: enabling environment and 6.b.1) various other SDG 6 indicators. These relationships can be argued not to preform symbiotically to each other, but instead to largely be the same thing. This is to say that the current IWRM assessment technique simply works really well in capturing the performance of these other indicators, as these indicators make up the definition of IWRM. In that sense some results of the study simply prove the effectiveness of the IWRM survey in capturing the definition of IWRM.

5 Conclusion

The results of the statistical correlation analysis suggest that Integrated Water Resources Management (IWRM) is an effective tool for SDG 6 implementation. The research question: '*What is the correlation between countries ranking high/low in the implementation of IWRM (6.5.1) and their results on the other SDG 6 indicators?*, is thus answered. Correlations were explored pertaining to the performance of IWRM (6.5.1) with the performance of the other eleven SDG 6 indicators (6.1.1 – 6.b.1). The national 2012 IWRM survey data revealed significant, positive correlations between IWRM grouping and average access to drinking water (6.1.1), average access to sanitation (6.2.1), and absolute Official Development Assistance (ODA) for water. The published, regional IWRM data (6.5.1) also revealed a statistically significant correlation with access to drinking water (6.1.1). Other significant, postive correlations within SDG are those pertaining to access to drinking water (6.1.1) and: ODA for water (6.a.1) and water management participation (6.b.1).

Although in determining a direct causal relationship much more extensive qualitative assessment would be required, the data correlation coefficients suggest that an improvement in IWRM, ODA aligned spending and participation will also improve linearly the access to drinking water or change in access to drinking water. Issues faced in doing the analysis can be summarized as the lack of data, the probable presence of not-missing-at-random data and global averages. In the future, better analysis of the SDG's can be carried out with the availability of more data.

5.1 Recommendations

The recommendations in this section are based on the results, discussion and conclusion points of this report. Their relevance varies from those intending to preform similar studies, to those providing the data – hence the two subsections.

5.1.1 Recommendations for Future Intralinkage Studies

Many recommendations can be made to improve the current study. Most of the arguments can implicitly be deducted from the *Discussion and Conlusion* chapter of the paper. The key points are summarized as followed:

The current intralinkage study could, in principal, largely be discredited given that none of the comparisons work with the indicators as defined by the Inter-Agency Expert Group (IAEG) in the *'Final list of proposed Sustainable Development Goal indicators* '. As explained, this was not a choice, but a limitation set by the limited data availability. For the credibility of correlation studies on Agenda 2030 directed at the non-academic public, one should thus consider explaining the differences between the promised data sets and the data sets that are available. Then a brief explanation should be given on how these differences could affect the current conclusions on correlations. Not doing so can possibly lead to misunderstanding as the current correlations of SDG 6 are not of Agenda 2030 indicators but of other data. Readers might currently be misled to believe that these trends hold also for the promised 2030 indicators – especially because they are treated to relative depth in the Synthesis Report *on* the 2030 Agenda. In another case, readers might wonder what the relevance is of the current correlation analysis considering that it *does not pertain* to the Agenda 2030.

Further recommendations lie in an adaption of the methodology. The current global analysis for regions shows that there is too much freedom in excusing the (outlying) positions of each region. Regional internal diversity is high and other parameters affecting the indicators of the regions are too different to allow consistent comparison. At the same time, regional comparison is very simple and the results are very easy to understand. When the data provides the possibility for a global, national comparison, there are often too many points with too high of a scatter to communicate any trend if it is observed. The recommendation is thus that in addition the regional comparisons, comparisons of the nations within each region is done also. This limits the amount of points in a graph, is almost as easy to understand and communicate as a regional analysis and allows the comparison of nations that are subject to similar environmental, social and economic pressures. Unfortunately, this method was only discovered in the later phases of this report, and thus it has only been carried out to a limited extent for the national IWRM data set trends with 6.1.1 and 6.2.1. A second, but more labour intensive solution, as mentioned in the discussion above, would be the division of regions into sub-regions. This would also increase the data points from only a few big regions to many more while reducing the issues of internal diversity.

This correlation analysis was carried out manually with the utilization of Microsoft Excel. Provided the many (sub-) datasets, I would recommend that a license for statistical analysis software is purchased or leased so that future analysis may be carried out much more rapidly and possibly more accurately as it is less prone to human error. It would save considerable time in processing data which would allow for a much more thorough qualitative analysis on the correlations.

Based on the conclusions, recommendations with regards to further data analysis should be carried out focusing first on national data sets, as these datasets present the greatest probability of showing correlation with others. A closer look also needs to also be taken in identifying correlations with the 6.1.1 and 6.2.1 locality (urban and rural) disaggregations. In this study, this was done only minimally for comparison with the 6.b.1 dataset on participation which also provided similar disaggregations.

5.1.2 Recommendations for Data Collecting Institutes

Although understanding that the purpose of data collection by the respective IAEG mandated institutes is not solely for the purpose of providing data for the 2030 Agenda on Sustainable Development, recommendation should still be made that data standardization is discussed. The IAEG specifies that "Sustainable Development Goal indicators should be disaggregated, *where relevant*, by income, sex, age, race, ethnicity, migratory status, disability and geographic location, or other characteristics, in accordance with the Fundamental Principles of Official Statistics (General Assembly resolution 68/261)" (IAEG, 2016). Yet in reality, very few data sets have done so even for the most basic disaggregation, namely by nation or by province. The reason why this is so important is that a variable amount of information is lost when comparing datasets of different temporal and spatial resolution for an inconsistent set of countries or regions. Given the repeated stressing of the importance of the Agenda 2030, options should be explored to what extent data standardization is possible and in what form it should be implemented.

A second recommendation with regards to the data is to encourage the UNEP-DHI partnership to publish their national IWRM data on the UNDESA-SD SDG dataportal. Once the data is published, it should no longer be an issue to use it for publication of the SR report and other research papers. If the data is not published but instead permission is given by the partnership to use this data, publication should still be encouraged so that others may validate and check the reports current findings and/or, of course, conduct their own analyses with regards to IWRM. The integrity and believability of findings suffer when the data used to come to those conclusions is not open for insight by academics or critics, and the IWRM (6.5.1) data as currently presented on the dataportal (proportion of countries with a specific level of IWRM (developing, not yet implemented, implementing, etc..) in a region, does not provide the same opportunities to uncover trends as the national data as explored in chapter 3.

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APPENDIX I: Outliers in Trends

Interesting for the intralinkages investigation is finding explanation for those regions that do not adhere to the possible trends between two indicators. This section explores some of the possible explanation for the outlying positions of some regions with regards to the global trends.

IWRM and Drinking Water Access

In this case, Latin America & the Caribbean (4), Northern Africa (5), and Western Asia (9) present themselves as non-typical with respects to the other regions on access to drinking water (6.1.1) and IWRM (6.5.1).

Western Asia (9): is characterized by the economic growth spurt of the region. The regional economic setting is characterized by the growth of the nations on the Arabian Peninsula. The financial gains from controlling significant portions of the worlds' oil reserves have been redirected into major infrastructural investments to sustain future growth and provide utilities to its citizens. Where budget allocation is a process that can happen relatively quickly, IWRM policies, strategies, institution and instruments require much longer to develop. It is not unthinkable therefore that the financing for drinking water access and other utilities has resulted in relatively immediate improvement of drinking water access, while the actual IWRM policies/institutions and management tools lag behind.

A second explanation for the relatively low ranking on IWRM despite the high drinking water access may be sought in semantics. The last clause of the definition of IWRM concludes that IWRM exists only if the practice comes 'without compromising the sustainability of vital ecosystems'. It can so be reasoned that very effective drinking water projects that would otherwise be considered as IWRM, are not considered so because they are unsustainable and/or pose a threat to ecosystems. Fossil ground water withdrawal for agricultural or drinking water purposes has such an effect. Fossil groundwater is considered unrenewable as its withdrawal implies the mining of aquifer storage reserves that recover extremely slowly, and can effect groundwater dependant ecosystems elsewhere. The temptation for cheap, drinking water is nonetheless great in water stressed countries. Saudi Arabia is placed to hold a 85% share of the water demand met by non-renewable groundwater aquifer mining in 2006 (Foster and Loucks, 2006). In effect this may provide greater access to safe drinking water, but is rarely considered good IWRM given the nature of its implications.

Latin America and the Caribbean (4): While there are few high IWRM countries, this region still scores well on drinking water access. The reason for this is possibly climatic. Even compared to other tropical regions (South-East Asia, Sub-Saharan Africa), South America is the continent with the most fresh water resources. The widespread availability of freshwater gives the region a high baseline which translates into a competitive advantage in providing access to drinking water over drier regions. What remains then is the improvement of these sources to safe standards, as water quantity says little about water quality. Then there also remains the issue of distribution. Due to this natural advantage and despite the rising economic water scarcity, it scores lower on IWRM than more water stressed regions such as Eastern Asia and the developed region. Both these two regions have proportionally at least 3 times as many countries with high or advanced IWRM implementation. Perhaps it is due to the illusion of an abundance of freshwater resources that IWRM is not regarded as important or needed. This would explain the low position of the effective implementation of existing management instruments on the political agenda (WWAP, 2012). In the World Water Development Report 2015, the United Nations Economic Commission for Latin America

and the Caribbean (UNECLAC) further summarizes the water governance of Latin American and the Caribbean to poses over extremely limited formal institutional capacity to manage water resources. Inefficient public administration, widespread informality and weak regulatory institutions are among those blamed for weak water governance systems (WWAP, 2015), and thus probably also resulting in a low IWRM score.
on the entirety of the spectrum of indicators.

Northern Africa exemplifies the opposite. A region where freshwater resources are relatively low, but IWRM is implemented or at an advanced stage of implementation for all of the countries. The data excludes Libya, for which there is no estimate of the proportion of population with access to safe drinking water. For Northern Africa, it can be concluded that IWRM is not a limiting variable anymore on the achievement of 6.1.1 as it scores extremely well on IWRM. Other variables instead would then presumably be limiting the achievement of 6.1.1. of which water stress 6.4.2 is to some likeliness a contributor.

ODA and Drinking Water Access

Northern Africa and **Western Asia** show relatively mild or non-existent slopes despite their room for improvement (<90% population with access to drinking water). A possible explanation for these outliers to the trend may be sought in the ambiguity created by the wide range of possible investments that can be made with the ODA. As the data is published, there no distinguishing between the different kinds of water projects that the ODA funds are attributed to, nor does it give any indication of non- ODA spending. This thus provides room for numerous, alternative fiscal scenario's that may be considered in explaining why certain regions do not fit the proposed trend between ODA and drinking water access improvement.

For **Western Asia**, the nearly horizontal slope is possibly due to costs of improving access to safe drinking water. The region faces high water scarcity and therefore has to often look to non-conventional methods in providing utility services. Desalinization is one such methods, but is an expensive and energy intensive process that comes both with high investment as well as high maintenance and operational costs. Access in Western Asia is also still relatively high ranked with approximately at least 90% of the population already having had access in the past 15 years.

For **Northern Africa**, ODA spending appears to also have little effect. Apart from the non-correlation with ODA alignment, the data indicates that change in drinking water access appears to have stagnated in general for this region. The recent political instability could be one explanation for this, but the trend appears to have been set even before the Arabian spring of 2011. *Reasons for sanitation improvement stagnation should again be explained in the general data analysis section of the Synthesis Report.*

APPENDIX II: Opposites and Drinking Water vs. Sanitation Trends

This appendix compares the trends as they are observed for drinking water or sanitation in the report and compares them to the trend of the other (sanitation or drinking water). It also provides counterexamples for the national, close-up comparisons of the 2012 IWRM dataset with 6.1.1 and 6.2.1. The juxtaposition and comparison of 6.1.1 and 6.2.1 with regards to the different trends will provide additional insight, while the counter examples on IWRM will show some of the exception with regards to correlation presented in the report.

Regional IWRM vs Access to Drinking Water and Sanitation

Chapter 2 begins by describing the trends between IWRM vs. *Drinking Water* (Figure 15 and Figure 16). The same IWRM data is analysed for correlation with *sanitation*. Figure 25 shows the difference in the regional proportion of countries with high level IWRM versus performance on access to sanitation as percent of regional population. Figure 26 shows the same data but normalized. Unfortunately, no clear trend that is applicable to all the regions can be identified.

LEGEND	
1	Caucasus and Central Asia
2	Developed regions
3	Eastern Asia
4 □	Latin American and Carib.
5 Δ	Northern Africa
6	Oceania
7	South-Eastern Asia
8	Southern Asia
9 x	Western Asia
10	Sub-Saharan Africa

Figure 15. *6.5.1 vs. 6.1.1*

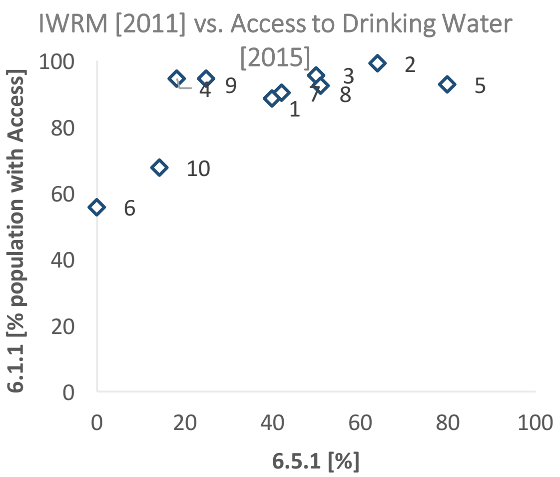


Figure 16. *6.5.1 vs. 6.1.1 normalized.*

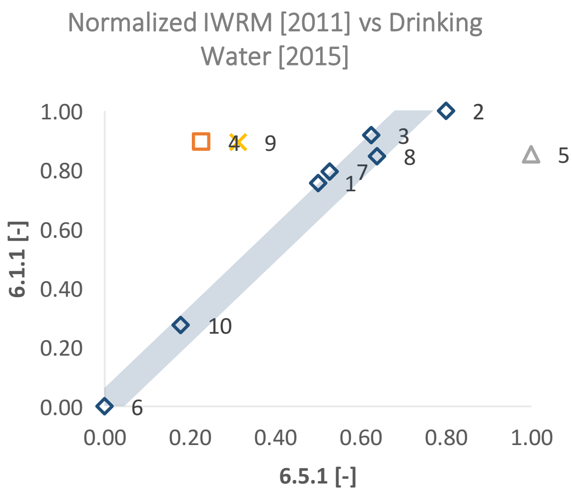


Figure 25. *6.5.1 vs. 6.2.1*

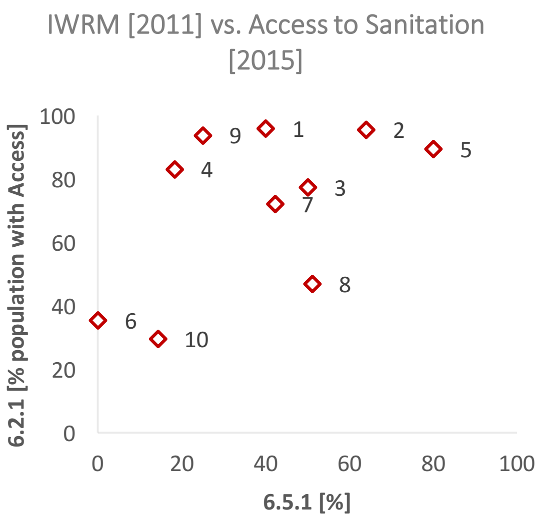
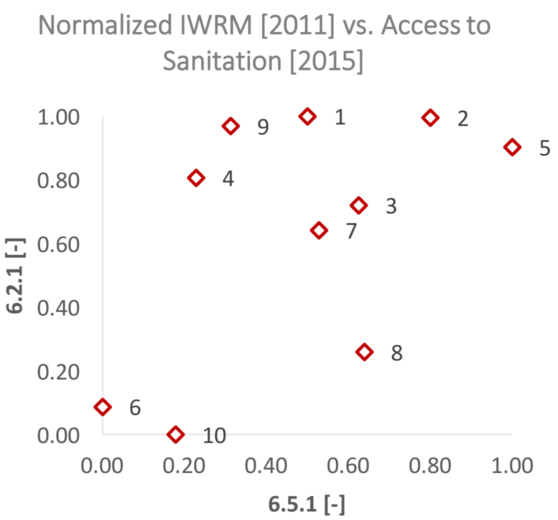


Figure 26. *6.5.1 vs. 6.2.1 normalized*



Regional IWRM vs Change in Access to Drinking Water and Sanitation

The chapter continues to describe the trend found with IWRM and the improvement over five years on access to sanitation (Figure 17). Figure 3 was plotted for only those regions that have less than 90% access to sanitation, given that improvement in sanitation is difficult to achieve when approaching 100% access to sanitation. Figure 27 shows the same IWRM data set versus improvement on access to drinking water for *all* the regions, as only three regions have less than 90% access (Caucus and Central Asia, (1) 88.6%; Oceania, (6) 55.7%; and Sub-Saharan Africa, (10) 67.7%).

LEGEND	
1	Caucasus and Central Asia
2	Developed regions
3	Eastern Asia
4 □	Latin American and Carib.
5 Δ	Northern Africa
6	Oceania
7	South-Eastern Asia
8	Southern Asia
9 x	Western Asia
10	Sub-Saharan Africa

Figure 17. *6.5.1 vs. change 6.2.1*

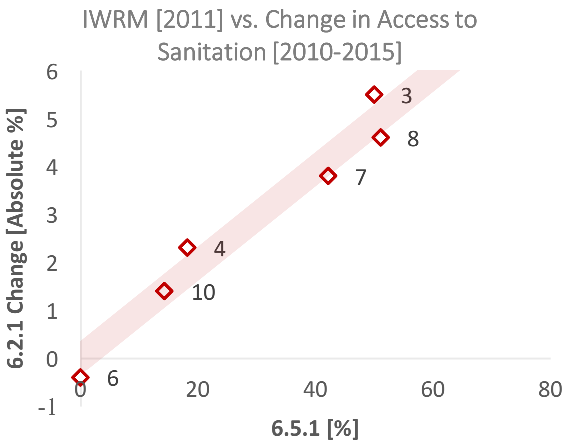
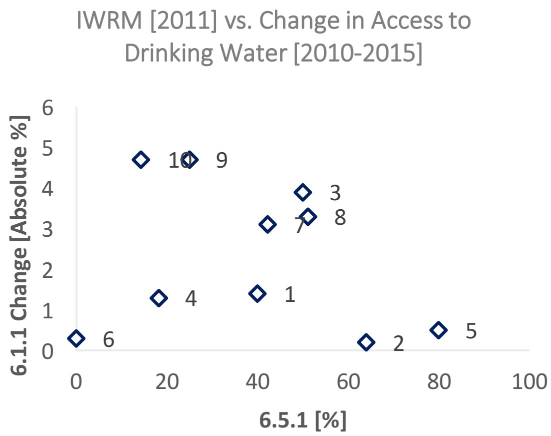


Figure 27. *6.5.1 vs. change 6.1.1*



Regional Participation vs Change in Access to Drinking Water and Sanitation

Figure 21 describes the average change in national drinking water access by region by proportion of countries with a high level of participation in Water Management Programs. For this comparison, it makes more sense to compare a change in access to sanitation with participation in Sanitary programmes (Figure 26) which does not show a trend.

Figure 21. *6.b.1 vs. change*

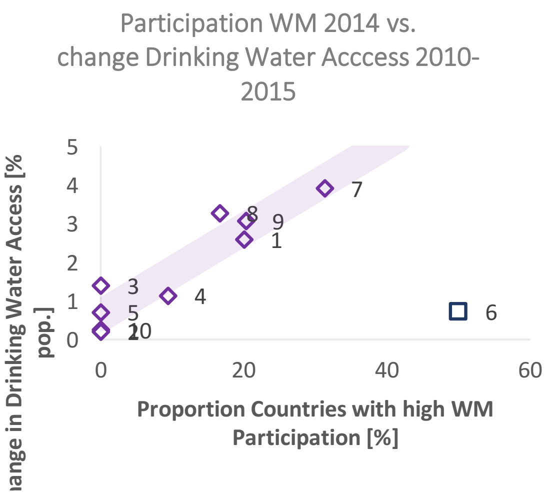
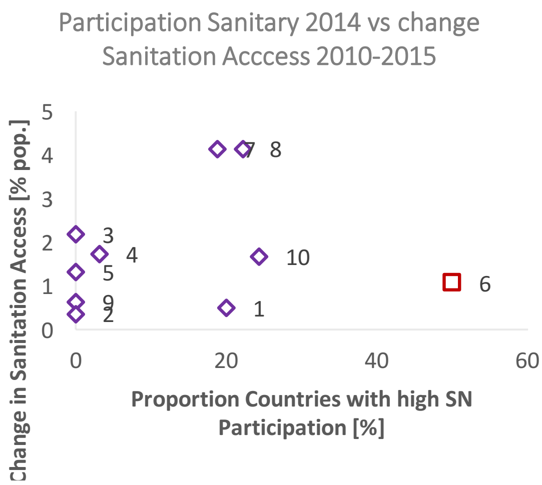


Figure 28. *6.b.1 vs. change 6.2.1*



Counterexample Change in Drinking Water with IWRM

Chapter section 3.2 begins by describing the positive trend between IWRM scores and drinking water access. The trend shows that nations with a higher IWRM score, also have a higher access to drinking water. To exemplify this trend, a selection of different nations in Sub-Saharan Africa was made that show how higher IWRM leads to greater improvements on drinking water access also. Although these nations present the 'best' possible examples, there are also several nations that reveal the opposite (Figure 29). As a nation with a relatively high IWRM for the region but a low improvement on 6.1.1, Zimbabwe shows the best counterexample. Also Sierra Leone with an extremely low IWRM, but very high improvement on 6.1.1, proves that many other variables other than IWRM are influencing improvement on 6.1.1.

Figure 5. *6.5.1 (2011) vs. change 6.1.1 (2010-2015). Sub-Saharan selection*

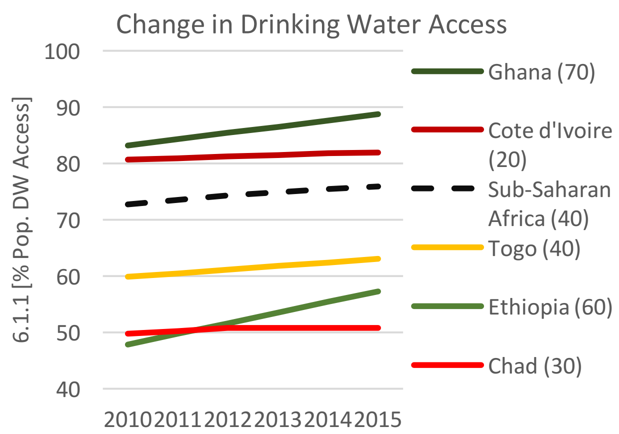
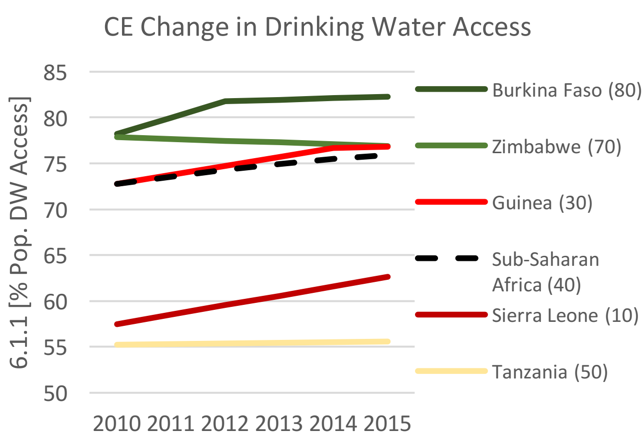


Figure 29. *6.5.1 (2011) vs. change 6.1.1 (2010-2015). Sub-Saharan selection, counter examples (CE)*



Counterexample Change in Sanitation with IWRM

The trends on IWRM and Change in Sanitation Access were also merited with a closer, in-depth analysis through country selection. Nations with approximately equal performance on 6.2.1 in 2010 but different IWRM scores (Cuba, Lithuania, Macedonia and Georgia) were compared (Figure 7). The comparison reinforced the concept of higher IWRM leading to faster improvements on 6.2.1. There are a few nations who, again, show the opposite however. In Figure 28, we notice how Jamaica hardly improves on 6.2.1 while Ecuador (with a far lower IWRM) improves much faster.

Figure 7. *6.5.1 vs. 6.2.1, high sanitation*

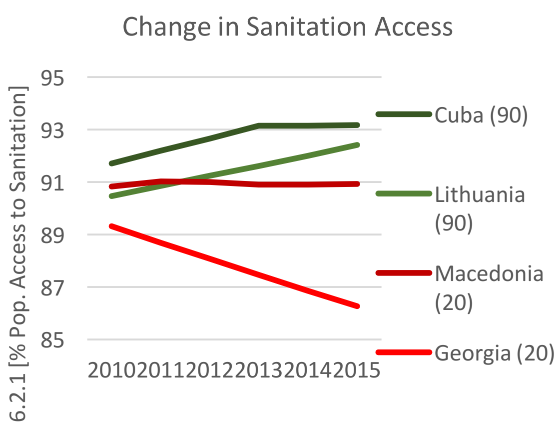
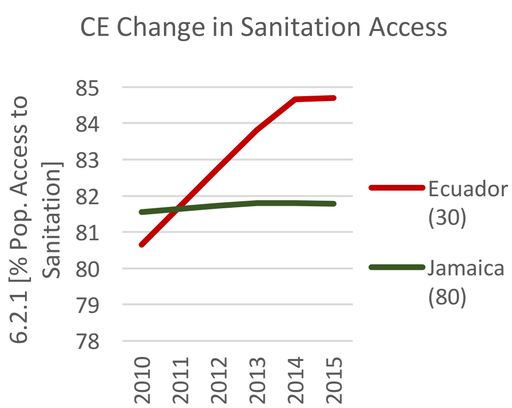


Figure 30. *6.5.1 vs. 6.2.1, sanitation access (~81%) nations counter examples (CF)*



APPENDIX III: OCEANIA AS AN OUTLIER

Where most regions adhere relatively well to the global trends, Oceania is often an outlier. For the trends between IWRM and drinking water access, Oceania has a very high percentage of community involvement, yet the expected change in drinking water access that comes with it, is not evidenced. With an average of 88% access to safe drinking water in 2015, it does not quite belong to the category of regions that are at or near the technical feasibility threshold (97%) either. Its position can be interpreted in one of two ways: one is where it outperforms its participation with regards to its change in drinking water access; and the other where change in drinking water access lags behind its high participation rate. The nature of the potential causal relationship is difficult to establish concretely, but given the specific context of the region it can to some extent be explained.

When not including Australia and New Zealand - which are incorporated into the developed region by this demographical division - Oceania becomes the smallest region demographically. The next smallest demographically is Central Asia, which already contains more than six times the population of Oceania. The citizens in the remaining sub regions of Oceania; Melanesia, Micronesia and Polynesia are scattered over the many archipelagic islands where the ocean forms significant geographic boundary in the translocation of people and goods. Both the small physical, demographical scale of the islands, as well as the size of the total populations, instigate a more natural, close cooperation between the respective, public and private water sectors and the people. A high participation can thus be explained as the high baseline for Oceania provided the concentration of the majority of the population to a select few islands. This implies significant geographical boundaries *between* the nations, but only, mostly political boundaries *within* the nations. The impact of it on effective change in drinking water access is likely limited due to the play of other unique variables. Non-conventional sources such imported bottle water, are a common source of water to many communities within the island states[13]. Bottled water alone, however, does not fall under the definition of 'improved water sources' as defined by indicator 6.1.1. Therefore, despite the high amount of countries with high levels of community participation in Oceania, the change in drinking water access as defined by 6.1.1 remains limited due the lacking pressure for improvement due to the availability of non-conventional alternatives such as imported water. More information on Oceania as an outlier can be found in Appendix IV. Also, as with the JMP report on Progress on Drinking Water and Sanitation, it should also be kept in mind that data from Oceania is limited. There are only very few data points on the small island states, of many of which date back several years (JMP 2012). This may again influence the regional average to such extent that it becomes not truly representative for a region with already such a limited population to sample from.

[13] Southwest States & Pacific Islands Regional Water Program. (2005). *Drinking Water Trends in the Pacific*.

APPENDIX IV: DATA AVAILABLILITY INFORMATION FROM METADATA

6.1.1: Access Drinking Water
From 2010 to present:

Asia and Pacific: At least 80% of the countries covering 90% of the population.
Africa: At least 60% of the countries covering 80% of the population.
Latin America and the Caribbean: At least 80% of the countries covering 90% of the population.
Developed regions: At least 90% of the countries covering over 90%.

Note: Data from 2000 to 2010 are available for roughly 50% of countries, covering at least 50% of the population in all regions.

6.2.1: Access Sanitation
From 2010 to present:

Asia and Pacific: At least 80% of the countries covering 90% of the population.
Africa: At least 60% of the countries covering 80% of the population.
Latin America and the Caribbean: At least 80% of the countries covering 90% of the population.
Developed regions: At least 90% of the countries covering over 90%.

6.4.2: Water Stress
Countries (2010 to present):
Asia and Pacific: 2
Africa: 6
Latin America and the Caribbean: 16
Developed regions: 24
Countries (2000-2009):
Asia and Pacific: 42
Africa: 49
Latin America and the Caribbean: 27
Developed regions: 47

6.5.1: IWRM
Total number of countries: 133 (69% of UN Member States) (UN-Water 2012). The following covers the region (MDG regional groupings): followed by the number of countries with data (/total countries in region) (as of 2012); followed by the percentage of countries with data.

Oceania: 5/12; 42%
Eastern Asia: 4/4; 100%
Southern Asia: 5/9; 56%
South-Eastern Asia: 9/11; 82%
Western Asia: 5/12; 42%
Caucasus and Central Asia: 5/8; 63%
Latin America & the Caribbean: 22/33; 67%
Developed regions: 38/50; 76%
Sub-Saharan Africa: 35/49; 71%
Northern Africa: 5/5; 100%
World: 133/193; 69%

6.a.1: Cooperation

Asia and Pacific: At least 80% of the countries covering 90% of the population.
Africa: At least 80% of the countries covering 90% of the population.
Latin America and the Caribbean: At least 80% of the countries covering 90% of the population
Developed regions: Some countries

Please note that these reflect availability of data on total water and sanitation ODA. Data on proportion included in government budget will be available through the current cycle of GLAAS (cf. 7.1, 10.1, and 10.2).

Time series of parameters under the indicator are available for 2008, 2010, 2012, and 2014.

6.b.1: Participation

Asia and Pacific: At least 50% of the countries covering 60% of the population.
Africa: Approximately 50% of the countries covering 50% of the population.
Latin America and the Caribbean: At least 60% of the countries covering 80% of the population.
Developed regions: At least 60% of the countries covering 60% of the population.

APPENDIX V: IWRM DATA TRANSLATION

As opposed to the 2017 questionnaire which consisted of only four components, the 2011 questionnaire counted a total of seven components. Some components are relatively identical to each other despite the differences among the questions that belong to them. An overview of the components in each questionnaire is provided below:

Table i: Component overview

2011 Survey Components	2017 Survey Components
1. Policy, Strategic Planning and Legal Framework	1. Enabling Environment
2. Governance and Institutional Frameworks	2. Institutions and Participations
3. Management Instruments	3. Management Instruments
4. Infrastructure Development and Financing	4. Financing
5. Sources of Financing for the Development of Water Resources	
6. Outcomes and impacts	
7. Priority Challenges	

The *Appendix VII: Survey Question Comparison* shows the choices that were made in linking the 2011 questions to those of 2017. The table that composes this appendix has served as a guide in how to aggregate the much more extensive 2011 survey into the more compact 2017 format. In many cases, the 2011 question could clearly and directly be linked to the 2017 questions. Remaining 2011 questions that could be attributed to 2017 questions which already had other well-defined 2011 question related to them, were often disregarded so as not to complicated comparison or reduce the quality of the data. In the cases where the additional 2011 question would sensibly further elaborate on the 2017 question, it was included in by aggregation.

Several options for aggregation were explored. Firstly, a direct translation of all the 2011 data per component into the 2017 data component was performed. Secondly, an aggregation of the selected for questions (Appendix VII) was carried out per component. The final method tested involved aggregating each of the selected for questions into the sub-component parts, which were then aggregated into the final components. An overview of the aggregation methods is provided in Table ii below:

Table ii: *Aggregation procedure*

Tier #	Definition of Tier	Example	Range
Tier I	Components	3. – Management Instruments.	1-7
Tier II	Sub-components	3.1 – Water Resources Development.	3.1 – 3.5
Tier III	Questions	3.1.b –Periodical assessment of water Resources.	3.1.a – 3.1.d

Mthd.	Aggregate	Procedure
1	Tier I + III	All 2011, original questions are aggregated into related component scores and then into a final score.
2	Tier I + III	Disregard Tier II division in aggregation of selected questions.
3	Tier I + II + III	Aggregate selected questions into sub components, and sub components into a final score.

The 2017 survey takes a more holistic view of component 4: financing. Instead of distinguishing between the different targets of financing, more attention is paid to the differences among different administrative levels in financing. In aggregating 2011 component 4 questions, all answers (excluding not applicable) were aggregated into a total component 4 score which was taken to be the component 4 score in the 2017 format. Table iii provides and overview of the actual questions pertaining to each survey with regards to component 4.

Table iii: *Component 4: Financing comparison*

	2011 Survey		2017 Survey
4.1	**Investment plans and programs**	**4.1**	**What is the status of financing for water resources development and management at the national level?**
4.1a	Water resources included in national infrastructure investment plans	4.1a	National budget for investment including water resources infrastructure
4.1b	Irrigation	4.1b	National budget for recurrent costs of the IWRM elements
4.1c	Energy/hydropower		
4.1d	Groundwater (e.g. boreholes, pumps and treatment)		
4.1e	Flood management		
4.1f	Water supply (domestic and industrial)		
4.1g	Wastewater treatment		
4.1g	Desalination of seawater		
4.1i	Rainwater harvesting		
4.1j	Natural systems (e.g. wetlands, floodplains and catchment restoration)		
4.2	**Mobilizing financing for water resources infrastructure**	**4.2**	**What is the status of financing for water resources development and management at other levels?**
4.2a	Financing for water resources included in national investment plans	4.2a	Sub-national or basin budgets for investment including water resources infrastructure
4.2b	Financing for irrigation	4.2b	Revenues raised from dedicated levies on water users at basin, aquifer or sub-national levels
4.2c	Financing for energy/hydropower	4.2c	Financing for transboundary cooperation
4.2d	Financing for groundwater (e.g. boreholes, pumps and treatment)		
4.2e	Financing for flood management		
4.2f	Financing for water supply (domestic and industrial)		
4.2g	Financing for wastewater treatment		
4.2h	Financing for desalination of seawater		
4.2i	Financing for rainwater harvesting		
4.2j	Financing for natural systems (e.g. wetlands, floodplains and catchment restoration)		

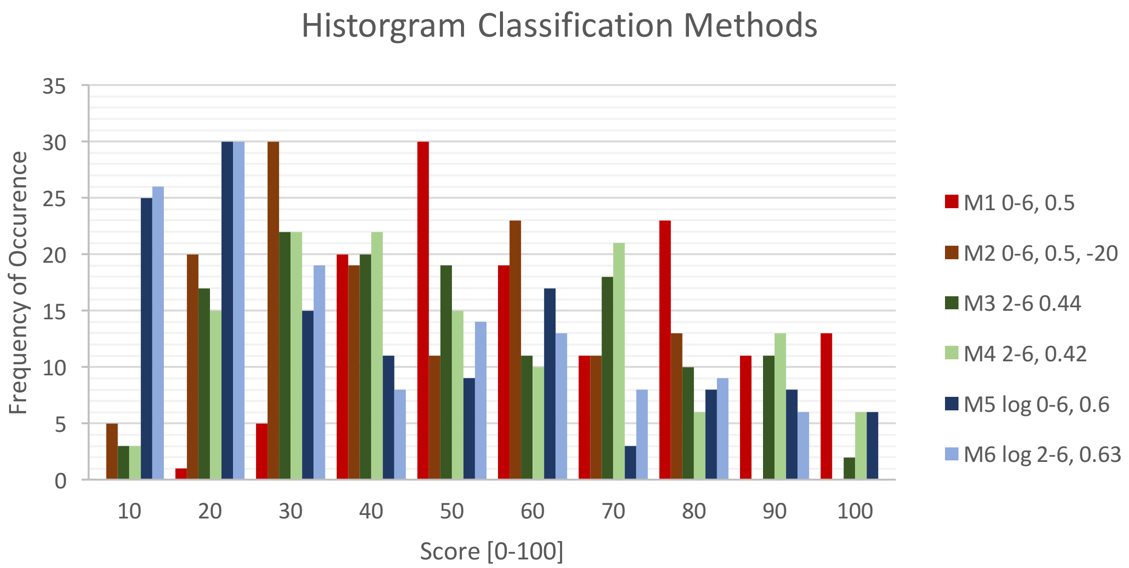
Although the precision most certainly increases with the different methods, the actual impact of the different methods on the scoring of each country was usually only a change of ±10 or 20 points. Aggregation provided us the answers of the 2011 data in the 2017 format. After this conversion, the data would still have to be translated into a 0-100 scoring.

Because the surveyed were explicitly asked to answer in accordance to the following provided thresholds: Not applicable (1), 0-20 (2), 20-40 (3), 40-60 (4), 60-80 (5), 80-100 (6); the average score of 0-6 had to be translated to a score on 0-100. Both linear as well as logarithmic classification methods were explored (Table iv). Because the logarithmic classification would present a too negative, global impression of IWRM status (see Figure 22), the choice was made for a linear method. Interval steps of 0.44 per each 1/10 classes was taken for each score ranging from 2-6 so as to have only those nations with a perfect score (>5.96) scored 100 on IWRM. Figure 21 shows a histogram the distribution of performances for the different countries for different methods.

Table iv: Classification Methods

Method Number		Classification	Range	Intervals	Remarks
Method 1	M1	Linear	0 – 6	0.5	Includes 'not applicable'
Method 2	M2	Linear	0 – 6	0.5	- 20 from final score
Method 3	M3	Linear	2 – 6	0.44	>5.56 scores 100
Method 4	M4	Linear	2 – 6	0.42	>5.97 scores 100
Method 5	M5	Logarithmic	0 – 6	0.6	Includes 'not applicable'
Method 6	M6	Logarithmic	2 – 6	0.63	Most nations score <30

Figure 22. *Histogram Classification Methods*



This method 3 procedure was carried out through a simple form of as formulated below:

$$P^n = 2 + n * 0.44$$

$$I_{qc}^t = \begin{cases} 10 & if\ x_{qc}^t < P^1 \\ 20 & if\ P^1 < x_{qc}^t < P^2 \\ \dots & if\ P^n < x_{qc}^t < P^{n+1} \\ 100 & x_{qc}^t < P^{10} \end{cases}$$

Where P^n is the boundary per class numer *n* (1-10), I_{qc}^t is the IWRM score and x_{qc}^t is the aggregated survey answer for 2017 question *q* (6.5.1) for specific country *c* at time *t* (2011).

After classification, the IWRM scores were compared to the data for other indicators of SDG 6. This was done completely in accordance to the procedures and methodologies discussed in Appendix II: *Method and Approach.*

APPENDIX VI: SURVEY QUESTION COMPARISON

The table below shows the choices that were made in linking the 2011 questions to those of 2017.

1. Policy, Strategic Planning and Legal Framework			
2017		**2011**	
1.1a	National water resources **policy,** or similar	1.1a	National/federal water resources policy
1.1b	National **water resources law(s)**	1.1c	National/federal water laws
1.1c	National **integrated water resources management** (IWRM) **plans**, or similar	1.1e	National or federal integrated water resources management plan/s or equivalent strategic plan document/s
1.2a	**Sub-national** water resources **policies** or similar	1.1b	Sub-national/provincial/state water resources policy
1.2b	**Basin/aquifer management plans** or similar, based on IWRM	--	**3.1a** Basin studies for long-term development and management of water resources.
1.2c	Arrangements for transboundary water management in most important basins / aquifers	1.3b	Transboundary water resources management agreements for specific river basins
		3.2L	Cooperative programs managing transboundary water resources
1.2d	FEDERAL COUNTRIES ONLY: **Provincial/state water resources laws**.	1.1d	Sub-national/provincial/state water law
---	Not included	1.2a	Integrated national policy/strategy/plan for land and water resources management
		1.2b	Poverty Reduction Strategy (PRS) with water resources management component
		1.2c	National Strategy for Sustainable Development
		1.2d	National Development Plan with water resources management component
		1.2e	National Environmental Action Plan water resources management component
		1.2f	National climate change adaptation policy/strategy/plan with water resources management component
		1.2g	National Agricultural Plan with water resources management component
		1.2h	National energy policy/strategy/plan with water resources management component
		1.2i	National desertification policy/strategy/plan with water resources management component
		1.2j	National wetland policy/strategy/plan with water resources management component
		1.2k	National biodiversity policy/strategy/plan with water resources management component
		1.1g	Water efficiency in integrated water resources management plan or equivalent
		1.1g	Water efficiency in integrated water resources management plan or equivalent
		1.3a	Regional/sub-regional water resources management agreements

2. Governance and Institutional Frameworks			
2017		**2011**	
2.1a	National government authorities capacity for leading implementation of national IWRM plans or similar	-	Not Included
2.1b	Coordination between national government authorities representing different sectors on water resources, policy, planning and management	2.1d	Mechanisms for cross-sector management of water resources
2.1c	Public participation in water resources, policy, planning and management at national level.	2.2c	Involvement of general public, civil society organizations and non-government organizations in water resources management and development at the **national level**
2.1d	Business participation in water resources development, management and use at national level.	2.2d	Involvement of the private sector in water resources management and development at the **national level**
2.1e	Gender-specific objectives for water resources management at national level	2.2g	Gender mainstreaming in water resources management and development
2.1f	Developing IWRM capacity at the national level	2.3a	Assessment of capacity needs in water resources management at national level
		2.3b	Assessment of capacity needs in water resources management at sub- national level
		2.3c	Programs for capacity development in water resources management institutions/organizations at national level
		2.3d	Programs for capacity development in water resources management institutions/organizations at sub-national levels
		2.3e	Programs for in-service training of staff/professionals in water resources management
		2.3f	Water resources management in the technical/higher education curriculum
		2.3g	Research programs in water resources management
2.2a	Basin/aquifer level organizations for leading implementation of IWRM plans or similar.	2.1a	Mechanisms (e.g. commissions, councils) for river basin management
		2.1b	Mechanisms for management of groundwater
		2.1c	Mechanisms for management of lakes

2.2b	Public participation in water resources, policy, planning and management at the local level	2.2e	Involvement of general public, civil society organizations and non-government organizations in water resources management and development at the basin level
		2.2f	Involvement of the private sector in water resources management and development at the **basin level**
2.2c	Gender-specific objectives at sub-national levels	2.2g	Gender mainstreaming in water resources management and development
2.2d	Gender-specific objectives and plans at transboundary level	2.2g	Gender mainstreaming in water resources management and development
2.2e	Organizational framework for transboundary water management for most important basins / aquifers	2.1e	Mechanisms for transboundary water resources management

3. Management Instruments

2017		2011	
3.1a	National monitoring of water availability	3.1b	Periodical assessment of water resources
		3.3b	Monitoring of surface water quantity
		3.3c	Monitoring of ground water quantity
3.1b	Sustainable and efficient water use management	3.2d	Programs for efficient allocation of water resources among competing uses
		3.2f	Programs for allocating water resources that include environmental considerations
		3.2g	Demand management measures to improve water use Program for re-use or recycling of water in all sectors
		3.2h	Program for re-use or recycling of water
		3.3f	Monitoring of water use
		3.3g	Monitoring of water use efficiency
		3.4c	Programs for transferring improved and cost effective water saving technologies
		3.5b	Subsidies for promoting water efficiency
3.1c	Pollution control	3.3d	Monitoring of water quality
3.1d	Management of water-related ecosystems	3.1d	Programs to value water-related or dependent ecosystem services
		3.2i	Programs to evaluate environmental impacts of water projects
		3.2m	Programs to reverse environmental/ecosystem degradation
		3.3e	Monitoring of aquatic ecosystems
3.1e	Management instruments to reduce impacts of water-related disasters	3.2j	Programs to address water-related disasters (e.g. floods and droughts)
		3.2k	Programs to address climate change adaptation through water resources management
		3.3i	Forecasting and early warning systems
3.2a	Basin management instruments	3.1a	Basin studies for long-term development and management of water resources
		3.1c	Regulatory norms and guidelines for sustainable development of water resources
		3.2b	Surface water management program
3.2b	Aquifer management instruments	3.2a	Groundwater management program
3.2c	Data and information sharing within countries at all levels.	2.2a	Stakeholders have access to information on national water resources management and development
		3.3h	Water resources information system
3.2d	Transboundary data and information sharing between countries	3.4d	Mechanisms for exchanging information between countries
NS	NOT SPECIFIED	3.2e	Land/natural resources management programs that include water resources management components
		3.4a	Programs for information exchange and knowledge sharing of good practices
		3.4b	Programs for providing advisory (extension) services on water management issues to end users

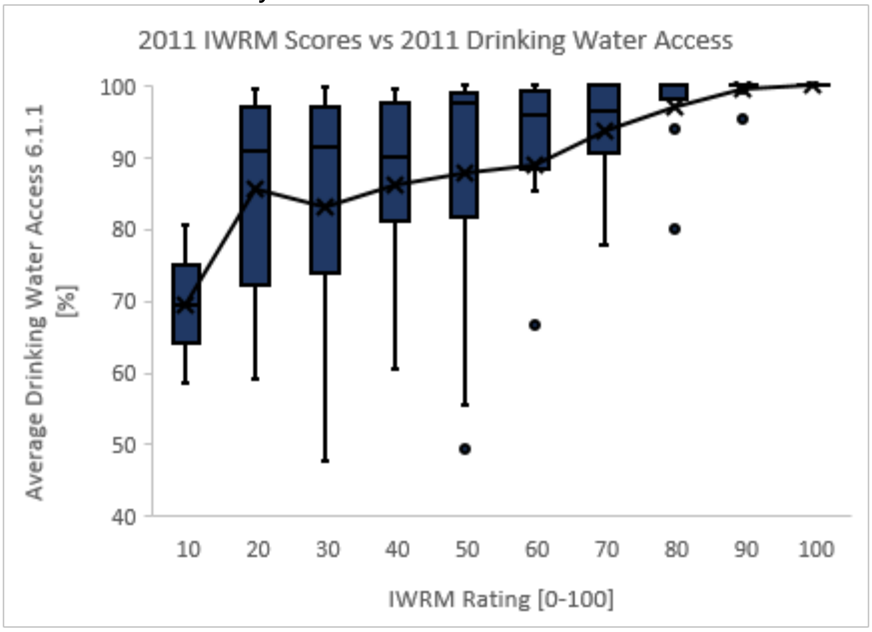
4. Infrastructure Development and Financing

2017		2011
4.1a	National budget for investment including water resources infrastructure	Total component 4 score. See Table iii
4.1b	National budget for recurrent costs of the IWRM elements	
4.2a	Sub-national or basin budgets for investment including water resources infrastructure	
4.2b	Revenues raised from dedicated levies on water users at basin, aquifer or sub-national levels	
4.2c	Financing for transboundary cooperation	

APPENDIX VII: ADDITIONAL GRAPHS

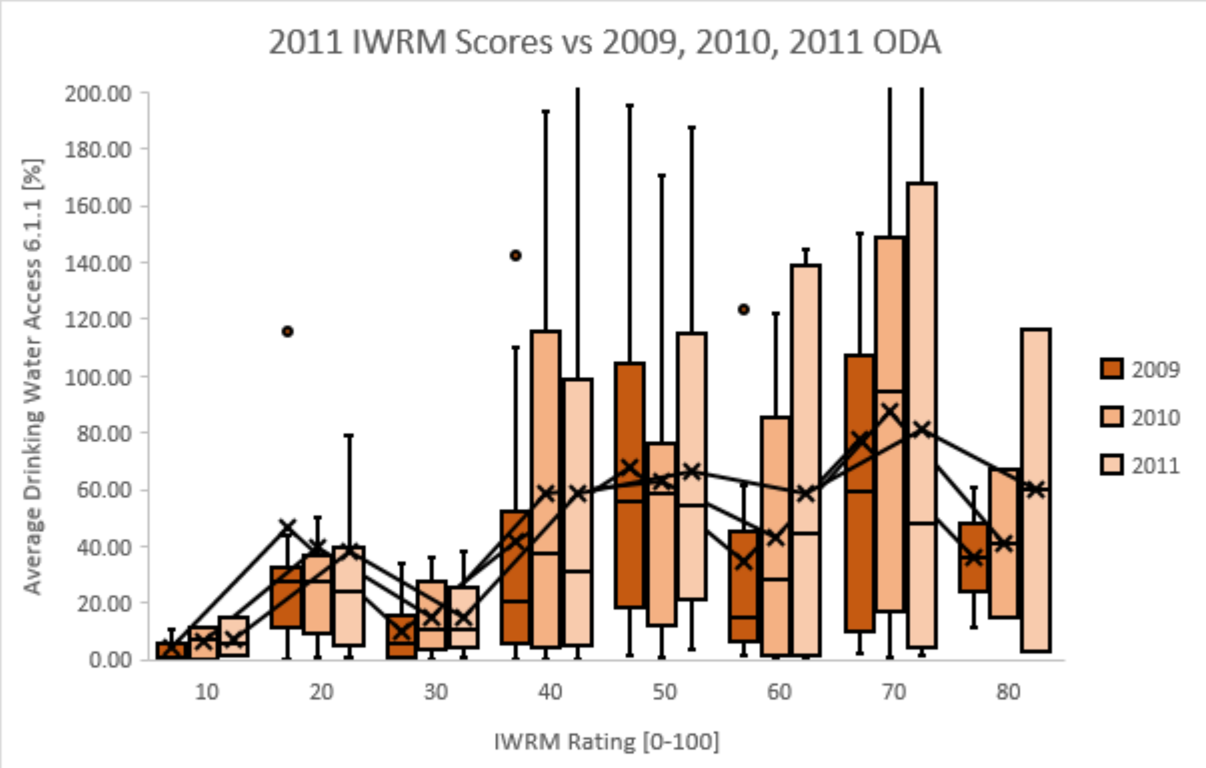
This appendix contains two graphs that supplement the graphs and conclusions with regards to drinking water and sanitation access and IWRM grouping. They are included because they may provide more valuable insight that was not discussed in the report itself.

Graph I. *Box-Whisker 6.5.1 vs. 6.1.1 by IWRM score.*



Graph II. *Box-Whisker 6.5.1 vs. 6.2.1 by IWRM score.*

Graph II. *Box-Whisker 6.5.1 vs. 6.a.1 (2009-2011) by IWRM score.*


2011 IWRM Scores vs 2009, 2010, 2011 ODA
Average Drinking Water Access 6.1.1 [%]
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
10
20
30
40
50
60
70
80
IWRM Rating [0-100]
2009
2010
2011